

**U.S. DEPARTMENT OF TRANSPORTATION**

**NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION**

**LABORATORY TEST PROCEDURE**

**FOR**

**FMVSS 106**

**Brake Hoses**



**ENFORCEMENT**

**Office of Vehicle Safety Compliance  
Room 6111, NVS-220  
400 Seventh Street, SW  
Washington, DC 20590**

**OVSC LABORATORY TEST PROCEDURE NO. 106**  
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# REVISION CONTROL LOG FOR OVSC LABORATORY TEST PROCEDURES

TP-106

TEST PROCEDURE		FMVSS 106		DESCRIPTION
REV. No.	DATE	AMENDMENT	EFFECTIVE DATE	
00				Original release signed by O.D.
01				
02				
03				
04				
05				
06				
07				
08	3/31/93			
09	8/26/05	69FR76298	12/20/2006	Substantive changes to incorporate several SAE Recommended Practices relating to hydraulic brake hoses, air brake hoses, vacuum brake hoses, plastic brake tubing, and end fittings.
10				
11				
12				

## 1. PURPOSE AND APPLICATION

The Office of Vehicle Safety Compliance (OVSC) provides contracted laboratories with Laboratory Test Procedures (TPs) which serve as guidelines for obtaining compliance test data. The data are used to determine if a specific vehicle or item of motor vehicle equipment meets the minimum performance requirements of the subject Federal Motor Vehicle Safety Standard (FMVSS). The purpose of the OVSC Laboratory Test Procedures is to present a uniform testing and data recording format, and provide suggestions for the use of specific equipment and procedures. Any contractor interpreting any part of an OVSC Laboratory Test Procedure to be in conflict with a Federal Motor Vehicle Safety Standard or observing any deficiencies in a Laboratory Test Procedure is required to advise the Contracting Officer's Technical Representative (COTR) and resolve the discrepancy prior to the start of compliance testing.

Contractors are required to submit a detailed test procedure to the COTR before initiating the compliance test program. The procedure must include a step-by-step description of the methodology to be used.

The OVSC Laboratory Test Procedures are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment which will assist in procuring the required compliance test data.

### NOTE:

**The OVSC Laboratory Test Procedures, prepared for use by independent laboratories under contract to conduct compliance tests for the OVSC, are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC Laboratory Test Procedures do not include all of the various FMVSS minimum performance requirements. Sometimes, recognizing applicable test tolerances, the Test Procedures specify test conditions which are less severe than the minimum requirements of the standards themselves. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits certification tests to those described in the OVSC Laboratory Test Procedures.**

## 2. GENERAL REQUIREMENTS

FMVSS 106 specifies labeling and performance requirements for motor vehicle brake hose, brake hose assemblies, and brake hose end fittings.

The purpose of S106 is to reduce deaths and injuries occurring as a result of brake system failure from pressure or vacuum loss due to hose or hose

## **2. GENERAL REQUIREMENTS....Continued**

assembly and plastic tubing or plastic tubing assembly rupture. The requirements apply to passenger cars, multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles, and to hydraulic, air, vacuum brake hose, plastic air brake tubing, brake hose and plastic air brake tubing assemblies, and brake hose and plastic air brake tubing end fittings for use in those vehicles.

The test procedures and methods outlined herein are based upon the requirements of S106 effective on December 20, 2006.

## **3. SECURITY**

The contractor shall provide appropriate security measures to protect the OVSC test specimens from unauthorized personnel during the entire compliance testing program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test specimens. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem will be sent to the IPM (with copy to the COTR) within 48 hours.

The contractor shall protect and segregate the data that evolves from compliance testing before and after each test. No information concerning the compliance testing program shall be released to anyone except the COTR, unless specifically authorized by the COTR, the COTR's Division Chief or by the Contracting Officer.

**NO INDIVIDUALS, OTHER THAN CONTRACTOR PERSONNEL, SHALL BE ALLOWED TO WITNESS ANY COMPLIANCE TEST UNLESS SPECIFICALLY AUTHORIZED BY THE COTR.**

## **4. GOOD HOUSEKEEPING**

Contractors shall maintain the entire compliance testing area, test fixtures and instrumentation in a neat and clean condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

## **5. TEST SCHEDULING AND MONITORING**

The contractor shall submit a test schedule to the COTR prior to testing. Tests shall be completed as required in the contract. All testing shall be coordinated with the COTR to allow monitoring by the COTR or other OVSC personnel.



## 6. TEST DATA DISPOSITION

The contractor shall make all preliminary compliance test data available to the COTR within four hours after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be furnished to the COTR in accordance with the contract schedule. Additionally, the contractor shall analyze the preliminary test results as directed by the COTR.

All backup data sheets, strip charts, recordings, plots, technicians notes, etc., shall be retained by the contractor for a minimum of 3 years after conclusion of each delivery order, purchase order, etc. The COTR shall direct final disposition at that time.

## 7. GOVERNMENT FURNISHED PROPERTY (GFP) AND TEST SAMPLES

### TEST SAMPLE IDENTIFICATION AND STORAGE

A test set of brake hoses shall consist of a quantity of test hoses plus a specific quantity which may be required for retest if necessary. The quantities shown below shall be used for tests unless amended by the contract.

HOSE TYPE	NO. OF TEST HOSES
Hydraulic	21
Air	15
Vacuum	10
Plastic tubing	23

Each test specimen shall be banded on one end or tagged at one end, and marked with a laboratory group number and individual sample number such as "001-2" for group 1, specimen number 2. The marking shall be suitable to withstand all tests and handling environments. Test flow and usage of the test specimens shall be as shown in Figures 1, 2, 3 and 4.

An inventory shall be made of the number, name and condition of samples received, and then the samples shall be stored in a dry, clean, dark, and dust free area to prevent damage to them in any manner which may affect test results.

## 7. GFP AND TEST SAMPLES....Continued

### FLOW SEQUENCE FOR BRAKE HOSE COMPLIANCE TESTS

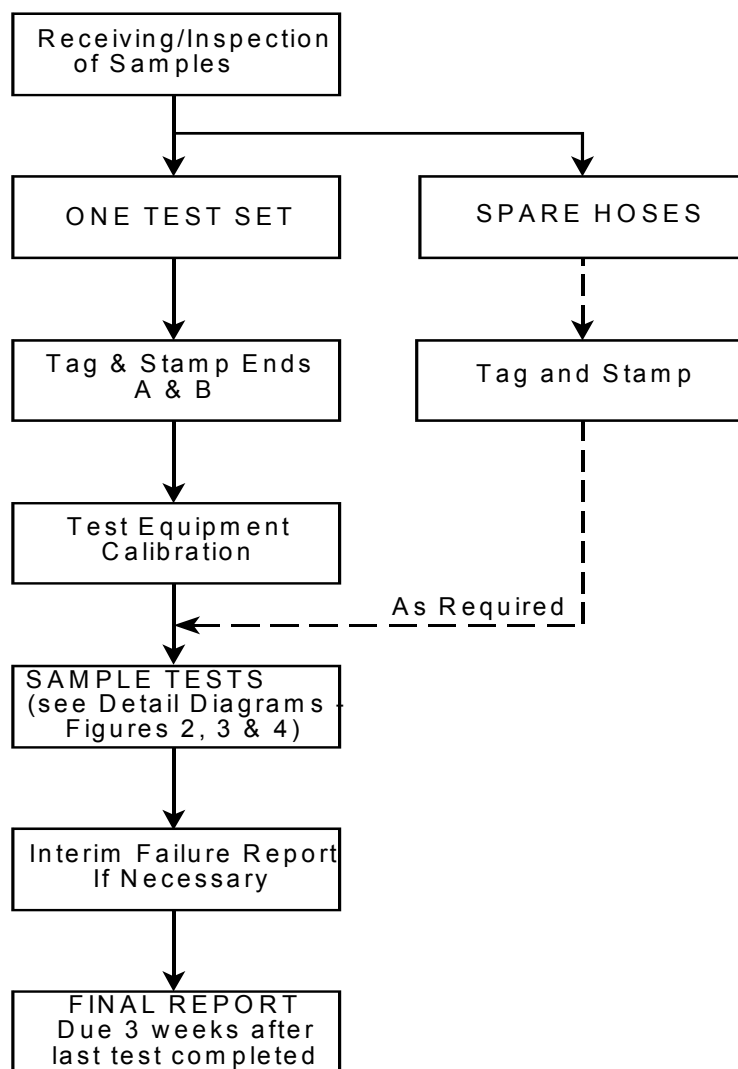


FIGURE 1

## Hydraulic Brake Hoses – Test Sequence

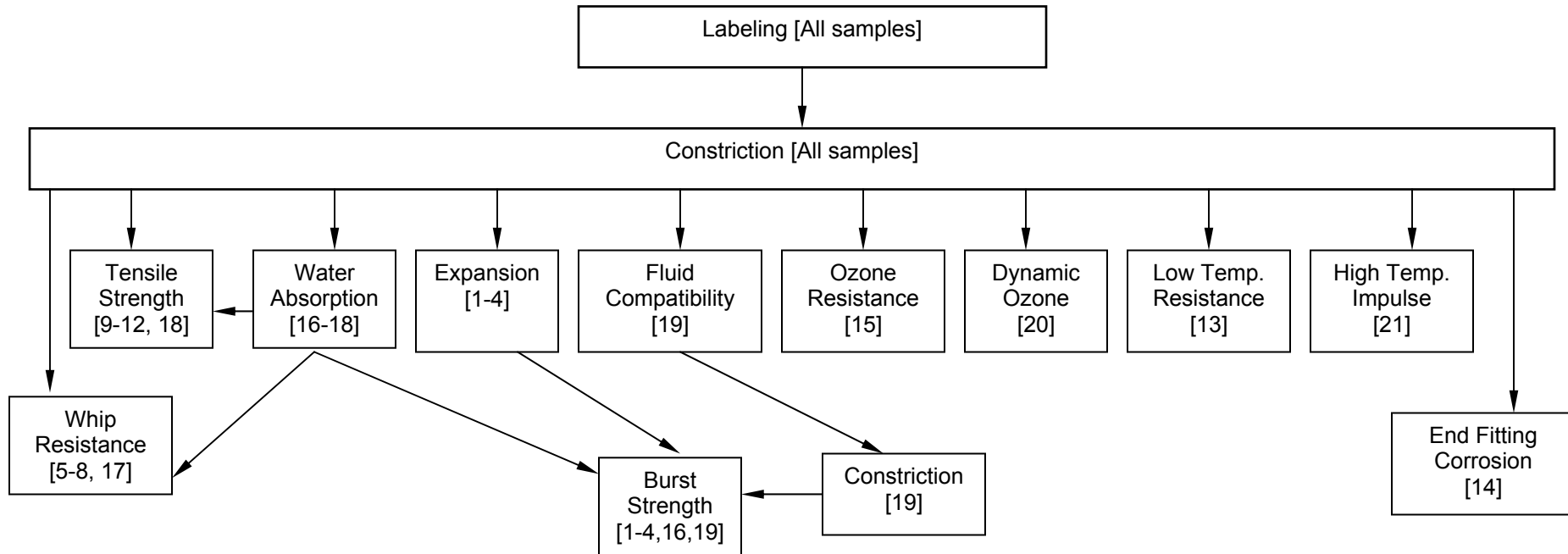


FIGURE 2

HYDRAULIC BRAKE HOSES – TEST REQUIREMENTS (FMVSS No. 106)			
Par.		Par.	
S5.3.1	Constriction	S5.3.8	Low Temperature Resistance
S5.3.2	Expansion and Burst	S5.3.9	Brake Fluid Compatibility, Constriction and Burst Strength
S5.3.3	Whip Resistance	S5.3.10	Ozone Resistance
S5.3.4	Tensile Strength	S5.3.11	Dynamic Ozone Test
S5.3.5	Water Absorption and Burst Strength	S5.3.12	High Temperature Impulse
S5.3.6	Water Absorption and Tensile Strength	S5.3.13	End Fitting Corrosion Resistance
S5.3.7	Water Absorption and Whip Resistance		

## 7. GFP AND TEST SAMPLES....Continued

## FLOW SEQUENCE FOR AIR BRAKE HOSES

NOTE: Numbers  
shown in [ ] are the  
TEST NUMBERS

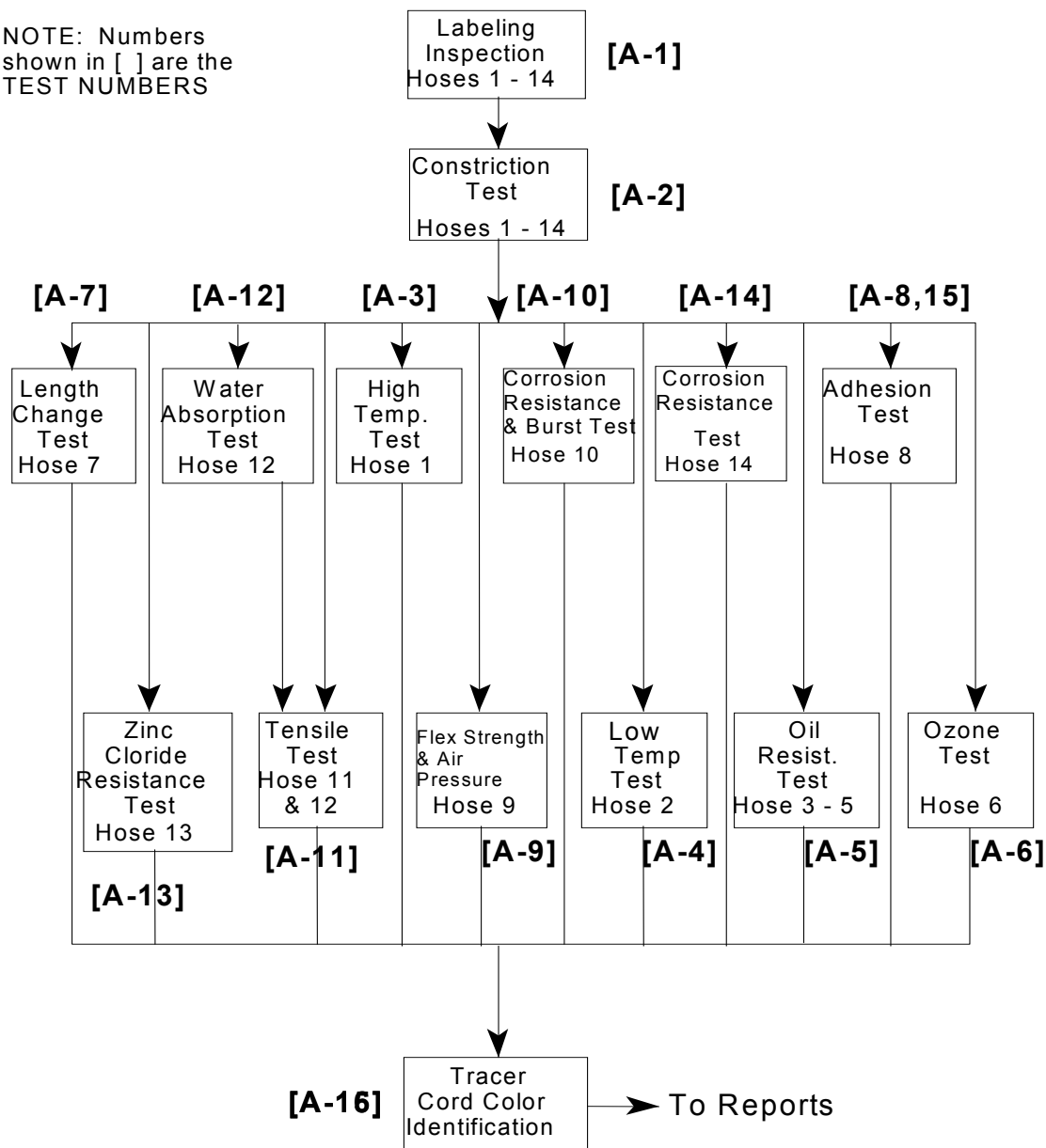
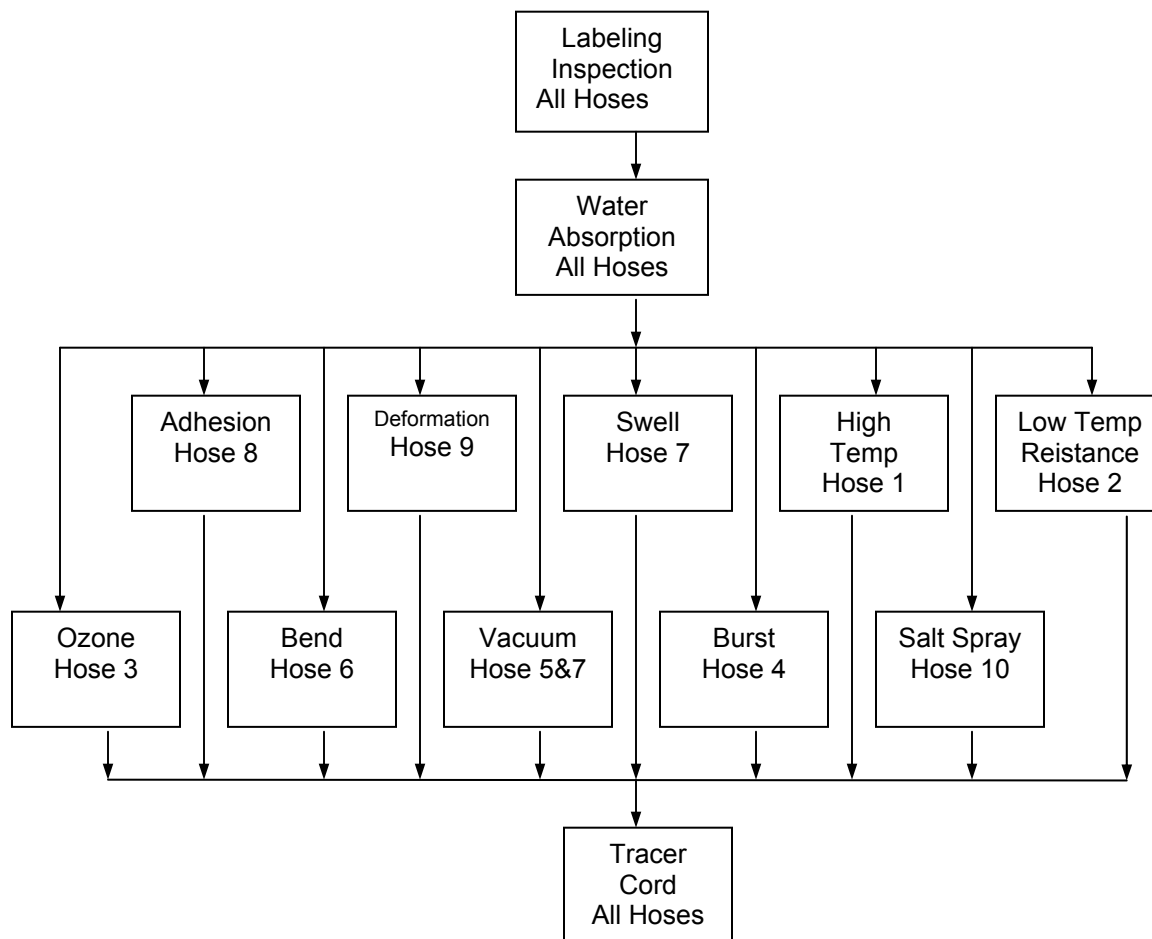


FIGURE 3

**7. GFP AND TEST SAMPLES....Continued****FLOW SEQUENCE FOR VACUUM BRAKE HOSES****FIGURE 4**

## 8. CALIBRATION OF TEST INSTRUMENTS

Before the contractor initiates the safety compliance test program, a test instrumentation calibration system will be implemented and maintained in accordance with established calibration practices. Guidelines for setting up and maintaining such calibration systems are described in MIL-C-45662A, "Calibration System Requirements". The calibration system shall be set up and maintained as follows:

- A. Standards for calibrating the measuring and test equipment will be stored and used under appropriate environmental conditions to assure their accuracy and stability.
- B. All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals NOT TO EXCEED TWELVE (12) MONTHS except for static types of measuring devices such as rulers, weights, etc., which shall be calibrated at periodic intervals not to exceed two years. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.
- C. All measuring and test equipment and measuring standards will be labeled with the following information:
  - (1) Date of calibration
  - (2) Date of next scheduled calibration
- D. A written calibration procedure shall be provided by the contractor which includes as a minimum the following information for all measurement and test equipment unless the calibration is performed by a licensed commercial facility.
  - (1) Type of equipment, manufacturer, model number, etc.
  - (2) Measurement range
  - (3) Accuracy
  - (4) Calibration interval
  - (5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)
- E. Records of calibration for all test instrumentation shall be kept by the contractor in a manner which assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COTR. The calibration system will need the acceptance of the COTR before the test program commences. The

## **8. CALIBRATION....Continued**

records of instrumentation used in a specific test are to be included in Appendix B of the Final Report.

## **9. PHOTOGRAPHIC DOCUMENTATION**

Each final test report shall include color photographs (minimum size 5 x 7 inches) of the test specimen to be tested (with additional photos highlighting all labeling, the end fittings, and any unusual features, e.g., armor, different types of tubing/hose in the assembly, and the test setup (with the sample mounted for testing) of each test. The sample under test must be easily identified from the photograph. Include all photographs in Appendix C of the final report.

In the event that a failure is suspected, if the failure effect is visible, the photographs shall show the point of failure from different perspectives to add significant details.

## **10. DEFINITIONS**

### **ARMOR**

Protective material installed on a brake hose/plastic tubing to increase the resistance to abrasion or impact damage.

### **BRAKE HOSE**

A flexible conduit, other than a vacuum tubing connector, manufactured for use in a brake system to transmit or contain the fluid pressure or vacuum used to apply force to a vehicle's brakes.

### **BRAKE HOSE ASSEMBLY**

A brake hose, with or without armor, equipped with end fittings for use in a brake system, but does not include an air or vacuum assembly prepared by the owner or operator of a used vehicle, by his employee, or by a repair facility, for installation in that used vehicle.

### **BRAKE HOSE END FITTING**

A coupler other than a clamp, designed for attachment to the end of a brake hose.

## **8. DEFINITIONS....Continued**

### **DIMENSIONAL DESCRIPTIONS**

For hose, a dimensional description such as "1/4-inch hose" refers to the Nominal Inside Diameter (I.D.).

For tubing, a dimensional description such as "1/4-inch tubing" refers to the Nominal Outside Diameter (O.D.).

### **FREE LENGTH**

The linear measurement of hose exposed between the end fittings of a hose assembly in a straight position.

### **PERMANENTLY ATTACHED END FITTING**

An end fitting that is attached by deformation of the fitting about the hose by crimping or swaging, or an end fitting that is attached by use of a sacrificial sleeve or ferrule that requires replacement each time a hose assembly is rebuilt.

### **PREFORMED**

A brake hose that is manufactured with permanent bends and is shaped to fit a specific vehicle without further bending.

### **RUPTURE**

Any failure that results in separation of a brake hose from its end fitting or in leakage.

### **VACUUM TUBING CONNECTOR**

A flexible conduit of vacuum that –

- Connects metal tubing to metal tubing in a brake system
- Is attached without end fittings
- When installed, has an unsupported length less than the total length of those portions that cover the metal tubing



## **11. PRETEST REQUIREMENTS**

### **IN-HOUSE TEST PROCEDURE**

Prior to conducting any compliance test, contractors are required to submit a detailed in-house compliance test procedure to the COTR which includes a step-by-step description of the methodology to be used. Written approval must be obtained from the COTR before initiating the compliance test program so that all parties are in agreement.

The test methods and procedures shall be based on the requirements of the following non-NHTSA documents wherein S106 shall take precedence followed by this Laboratory Test Procedure in case of conflict.

Society of Automotive Engineers (SAE) - -

SAE RM-66-04, Compatibility Fluid

SAE Standard J1703, Motor Vehicle Brake Fluid

American Society for Testing of Materials (ASTM) - -

ASTM E4-03, Standard Practices for Force Verification of Testing Machines

ASTM B117-03, Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM D471-98, Standard Test Method for Rubber Property—Effect of Liquids

ASTM G154-00 Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

ASTM G151-97, Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

ASTM D4329-99, Standard Practice for Fluorescent UV Exposure of Plastics

Military Specifications (MIL) - -

C-45662A, Calibration System Requirements

## 11. PRETEST REQUIREMENTS....Continued

The procedure shall contain instructions for the following:

- A. Sample tagging or marking
- B. Sample stowage
- C. Testing setup
- D. Testing procedure (step-by-step)
- E. Data recording
- F. Setup photographs
- G. Photographs of sample failure(s) illustrating point(s) of failure (include photographs of samples before testing)
- H. Description of failure(s)

### TEST DATA LOSS

A compliance test is not to be conducted unless all of the various test conditions specified in the applicable OVSC Laboratory Test Procedure have been met. Failure of a contractor to obtain the required test data and to maintain acceptable limits on test parameters in the manner outlined in the applicable OVSC Laboratory Test Procedure may require a retest at the expense of the contractor. The retest costs will include the cost of the replacement item of motor vehicle equipment and all costs associated with conducting the retest. The original test specimen used for the invalid test shall remain the property of OVSC, and the retest specimen shall remain the property of the contractor. If there is a test failure, the contractor shall retain the retest specimen for a period not exceeding 2 years. If there is no test failure, the Contractor may dispose of the test specimen upon notification from the COTR that the final test report has been accepted.

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within two (2) weeks after receipt of notification by the Contracting Officer that a retest is required. If a retest is conducted, no test report is required for the original test.

### TEST CONDITIONS

Unless otherwise specified, all tests and measurements shall be conducted under the following environmental conditions:

- A. Temperature  $75^{\circ}\text{F} \pm 5^{\circ}\text{F}$
- B. Relative Humidity  $50\% \pm 10\%$
- C. Atmospheric Pressure

## **11. PRETEST REQUIREMENTS....Continued**

Continuous recording of environmental temperature and relative humidity of the testing area shall be available during all tests. Test samples, unless otherwise specified, shall be stabilized at test room conditions for a period of at least 24 hours immediately prior to testing.

### **TEST PERSONNEL PERFORMANCE**

Personnel supervising and/or performing the compliance test program shall be thoroughly familiar with the requirements, test conditions, equipment for the test to be conducted, and safety requirements.

### **RECORDING OF TEST DATA**

Environmental data and test data shall be recorded on permanent strip charts, circular recording charts, or other acceptable media. Where permanent trace recording is not required, data will be recorded on standard report forms. Changes or corrections shall be made by drawing a line through the original entry, which must still remain legible, and adding the change alongside.

Test data will be submitted on the standard form Test Data Sheets specified for use in the final test report and shown in Section 15. Data will be typed before the sheets are submitted.

All test areas will require permanent trace recordings, where applicable, and before/after photographs where feasible. This is required to document that test conditions have been maintained as specified and that test criteria have been applied properly and uniformly throughout the test program. The test laboratory will submit for the approval of the contracting officer technical representative the type of permanent data history the laboratory proposes to use, based on test equipment and conditions applicable to each test.

When a sample failure does occur (sample WILL NOT be subjected to further testing), all of the charts and/or recordings for the failed sample or copies thereof shall be retained by the contractor along with the failed specimen unless otherwise directed by the COTR. This shall include a copy of the original operators hand written data as recorded during the test failure.

### **REPORTING FORMS**

The attached forms will be used for submission of data to the COTR. These forms will be reproduced on the Test Laboratory's stationary. One set of the data sheets will be used for each test set of brake hose assemblies. The final report

## 11. PRETEST REQUIREMENTS....Continued

data sheet information shall be typed. One set of data sheets shall consist of the following:

Data Sheets H-1 through H-12 for HYDRAULIC BRAKE HOSES

Data Sheets A-1 through A-15 for AIR BRAKE HOSES

Data Sheets V-1 through V-13 for VACUUM BRAKE HOSES

Data Sheets P-1 through P-13 for AIR BRAKE TUBING

### TEST DATA REPORTING SHEETS

In addition to the instrument recording data (which may be in analog form), all test data shall be recorded, in standard engineering units, on forms specifically prepared for this purpose such as those shown as the data sheet for each test. Changes or corrections of data sheets shall be made by drawing a line through the original entry, which must still remain legible, and adding the change alongside. The initials of the changer shall appear alongside the change.

Data sheets presented in a final form must be typewritten, signed, and include the date of test and date of sign-off. **The Report Number must appear at the top of each Data Sheet.**

### SAMPLE INFORMATION AND SUMMARY OF RESULTS

Preceding the test data sheets in the Final Report, there will be test specimen information and a summary of test results. These sheets will describe the articles tested, list the various tests performed, and indicate the result as either Pass (P) or Fail (F) as supported by the information tabulated on the test data sheets.

### PARTS DATA AND SUMMARY OF TEST RESULTS

- A. On parts data section of the reporting forms, each space shall be filled out. Where data is not present, write "NONE."
- B. Where a trademark is present, provide a recognizable sketch.
- C. Where the hose assemblies are not in a container, but certification statement is provided, write the statement. Where no certification is provided, write "NONE."

## 11. PRETEST REQUIREMENTS....Continued

- D. Sketch the data-bearing portion of the band on the bottom of the report form if a band is present.
- E. A hose, which fails one test phase, shall be subjected to NO FURTHER TESTING unless so directed by the COTR.

## 12. COMPLIANCE TEST EXECUTION

### A. TEST REQUIREMENTS - HYDRAULIC BRAKE HOSES

#### 12.A.1. - LABELING INSPECTION - (See Data Sheets H-1A, B & C)

All hydraulic test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.

All hydraulic test specimens, which are represented by a vehicle manufacturer to be used on a specific motor vehicle, need **NOT** have any marking and therefore are **NOT** subjected to any labeling PASS/FAIL criteria.

The data sheets contain a selection matrix allowing designation of the test specimens as being the following:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

**Vehicle Specific Assemblies** are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

**Aftermarket Assemblies** are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

**Special Test Assemblies** are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine or a whip test machine). Markings are NOT required on the **Special Test Assemblies**.

## **12. COMPLIANCE TEST EXECUTION....Continued**

### **HOSE MATERIAL MARKING**

The following hydraulic hose information may be present on the hose material of the assemblies to be tested and shall be recorded although the specimens are NOT subject to the PASS/FAIL criteria in all applications. The stripes described in (A) below are NOT required on Vehicle Specific Assemblies. Markings (B) through (F) are NOT required on the brake hose material in any assembly.

- (A) Two torque stripes parallel to the longitudinal axes of the hose and placed on opposite sides of the hose. One of the stripes may be interrupted by the information listed in (B) through (F), and the second by any other information that the manufacturer may provide. The two torque stripes are NOT required if the end fittings are such as to prevent the assembly from being installed in a twisted orientation in the vehicle.
- (B) The letters "DOT"
- (C) Hose Manufacturer's Identification
- (D) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).
- (E) Nominal Inside Hose Diameter (I.D. in inches or mm)
- (F) Expansion Characteristics (HR or HL)

### **END FITTINGS**

End fittings are NOT required to be marked EXCEPT if the assembly does not contain a band. In that case, except for Vehicle Specific Assemblies, at least one of the fittings shall be etched, stamped or embossed with the assembly manufacturer's identification.

### **HOSE ASSEMBLIES**

Except for Vehicle Specific Assemblies, each hydraulic brake hose assembly shall be labeled with a band (unless the option for end fitting marking has been selected) which shall be etched, stamped or embossed with the following.

- (A) The letters "DOT"
- (B) Manufacturer's Identification

## 12. COMPLIANCE TEST EXECUTION....Continued

### 12.A.2. – CONstriction TEST – (See Data Sheet H-2)

All test specimens shall be subjected to this test. This is basically a "go" or "no go" test in which a plug gage, an extended plug gage, or a drop ball is inserted in the upper end of a hose assembly, which is held vertically, and allowed to drop by gravity through the hose. The hose is acceptable if the gage passes through the hose and can be seen at the lower fitting. Failure to appear at the lower fitting shall be considered a test failure.

The constriction gage shall have a minimum diameter as follows (same diameter ball or rod is permissible):

. 0.079" for 1/8" I.D. hose (2.048 mm for 3.2 mm I.D.)

0.119" for 3/16" I.D. hose (3.072 mm for 4.8 mm I.D.)

. 0.159" for 1/4" I.D. hose (4.032 mm for 6.3 mm I.D.)

The gage plug diameter used by the test laboratory shall be shown under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate location of the constriction. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

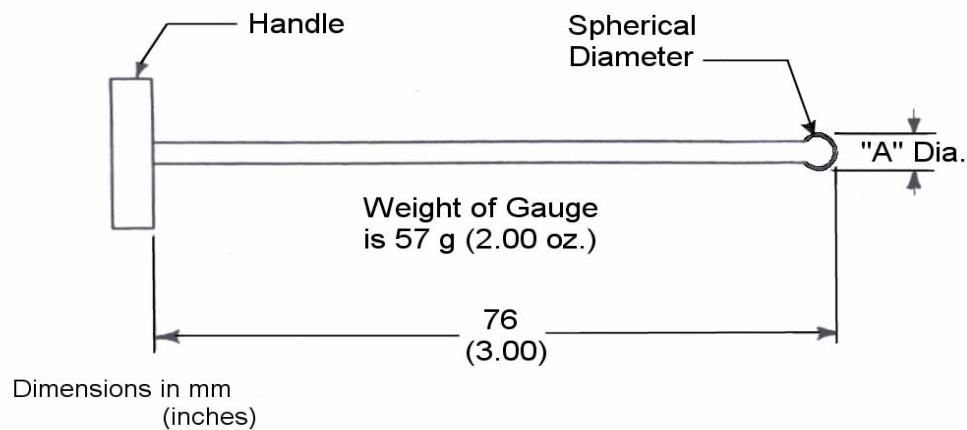
The brake hose constriction test requirements shall be met using at least one of the methods specified below.

#### **Plug gauge**

- (A) Utilize a plug gauge as shown in Figure 5. Diameter 'A' is equal to 64 percent of the nominal inside diameter of the hydraulic brake hose being tested.
- (B) Brake hose assemblies that are to be used for additional testing have constriction testing only at each end fitting. Other brake hose assemblies may be cut into three inch lengths to permit constriction testing of the entire assembly. Hose assemblies with end fittings that do not permit entry of the gauge (e.g., restrictive orifice or banjo fitting) are cut three inches from the point at which the hose terminates in the end fitting and then tested from the cut end.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (C) Hold the brake hose in a straight position and vertical orientation.
- (D) Place the spherical end of the plug gauge just inside the hose or end fitting. If the spherical end will not enter the hose or end fitting using no more force than gravity acting on the plug gauge, this constitutes failure of the constriction test.
- (E) Release the plug gauge. Within three seconds, the plug gauge shall fall under the force of gravity alone up to the handle of the gauge. If the plug gauge does not fully enter the hose up to the handle of the gauge within three seconds, this constitutes failure of the constriction test.



**FIGURE 5. CONSTRICTION TEST PLUG GAUGE**

### Extended plug gauge

- (A) The test in S6.12.1 may be conducted with an extended plug gauge to enable testing of the entire brake hose from one end fitting, without cutting the brake hose. The extended plug gauge weight and spherical diameter specifications are as shown in Figure 5, but the handle portion of the gauge may be deleted and the gauge length may be greater than 3 inches.
- (C) The required performance of the extended plug gauge in paragraph S6.12.1(e) is that after the plug gauge is released, the extended plug gauge shall fall under the force of gravity alone at an average rate of 1 inch per second until the spherical diameter of the extended gauge passes through all portions of the brake hose assembly containing hose. If the extended
- (D)



**13. COMPLIANCE TEST EXECUTION....Continued**

plug gauge does not pass through all portions of the brake hose assembly containing hose at an average rate of 1 inch per second, this constitutes failure of the constriction test.

**Drop ball test**

- (A) Utilize a rigid spherical ball with a diameter equal to 64 percent of the nominal inside diameter of the hydraulic brake hose being tested. The weight of the spherical ball shall not exceed 2 ounces (57 grams).
- (B) Hold the brake hose in a straight position and vertical orientation.
- (C) Hold the ball just above the end fitting.
- (D) Release the ball. The ball shall fall under the force of gravity alone completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second. Failure of the ball to pass completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second, constitutes failure of the constriction test.

**12.A.3. - EXPANSION TEST - (See Data Sheet H-3)****GENERAL -**

Hoses numbered 1 thru 4 shall be subjected to this test. All portions of the test setup exposed to high pressure shall be made of stainless steel tubing to eliminate any measurable expansion except for that due to the hose being tested.

The test fluid shall consist of distilled water and be free of air or gases. If at any time during the test an air bubble flows out of the hose, repeat the test allowing at least 5 minutes without pressure for the hose to contract to its original size when NOT pressurized.

Compression rings may be used for unconventional ends which have long metal tubes attached to the final end fitting. In these cases, the laboratory shall take adequate precaution to remove all trapped air.

## 12. COMPLIANCE TEST EXECUTION....Continued

### REQUIREMENTS –

The maximum expansion of a hydraulic brake hose assembly shall not exceed the values specified in the table below.

### PREPARATION

Measure the free length of the hose assembly and mount the brake hose assembly so that it is in a vertical straight position without tension while under pressure (See Figure 1 of FMVSS No. 106). Allow the test fluid to flow through the brake hose and the burette to bleed all gases from the system.

Close the valve to the burette and apply 1,500 psig for 10 seconds. Check the system for leaks. Release the pressure.

### PROCEDURE

Adjust the fluid level in the burette to zero. Close the valve to the burette. Apply a hydrostatic pressure of 1,000 psig at the rate of 1,500 psig/minute and hold this pressure for three seconds.

Close the lower valve and open the upper valve for 10 seconds to allow the fluid level in the burette to rise. This should be accomplished 3 times yielding 3 hose expansions. **Do not remove the hose between expansions.** The burette reading divided by 3 will give the actual hose expansion.

Repeat the Preparation and Procedure above for 1,500 psig and 2,900 psig.

This actual hose expansion must then be compared to the Maximum Allowable cc/ft. from the table below by dividing the Actual by the hose free length in ft. to determine the "PASS" or "FAIL" for each hose.

Pressure vs. Time shall be permanently recorded.

## 12. COMPLIANCE TEST EXECUTION....Continued

**TABLE**  
**MAXIMUM EXPANSION OF FREE LENGTH BRAKE HOSE (cc/ft)**

I.D.	Test Pressure					
	1,000 psi		1,500 psi		2,900 psi	
	Regular expansion hose	Low expansion hose	Regular expansion hose	Low expansion hose	Regular expansion hose	Low expansion hose
1/8 inch, or 3mm, or less	0.66	0.33	0.79	0.42	1.21	0.61
3/16 inch, or 4 to 5 mm	0.86	0.55	1.02	0.72	1.67	0.91
1/4 inch, or 6 mm, or more	1.04	0.82	1.30	1.17	Not applicable	Not applicable

### 12.A.4. - BURST STRENGTH TEST - (See Data Sheet H-4)

Hoses listed below shall be subjected to this test after completion of the Burst Strength test:

HOSE NO(S).	PRIOR TEST
1 - 4	Volumetric Expansion Test (H-3)
16	Water Absorption Test (H-10)
19	Brake Fluid Compatibility and Constriction Test (H-11)

Hoses subjected to the burst test need not be burst.

Connect the brake hose to a pressure system and fill it completely with water, allowing all gases to escape.

- (a) Brake hose larger than 1/8 inch or 3 mm diameter:  
Apply water pressure of 4,000 psi at a rate of 15,000 psi per minute, hold for 2 minutes at 4000 psi, and increase the pressure at the rate of 15,000 psi per minute until the pressure exceeds 5,000 psi.
- (b) Brake hose of 1/8 inch, 3 mm, or smaller diameter:  
Apply water pressure of 4,000 psi at a rate of 15,000 psi per minute, hold for 2 minutes at 4000 psi, and increase the pressure at the rate of 15,000 psi per minute until the pressure exceeds 7,000 psi.

## 12. COMPLIANCE TEST EXECUTION....Continued

Hydrostatic Pressure vs. Time shall be permanently recorded.

### 12.A.5. - WHIP TEST - (See Data Sheet H-5)

#### GENERAL -

Hoses numbered 5 thru 8 shall be subjected to this test and Hose #17 shall also be subjected after completion of the Water Absorption Test (H-10).

The whip machine shall be similar to that indicated in SAE J1401 and shall be dynamically balanced without hoses, and suitably mounted to avoid sympathetic vibrations. Hose couplings shall be mounted perpendicularly to the hose-mounting surfaces of the whip machine (movable and stationary headers with no twist in the hose). If at any time during the test, a hose fails due to a machine malfunction, **ALL** of the hoses in the test set shall be replaced by extra hoses from the group under test and the test will be repeated. The extra hoses must undergo the Constriction Test (H-2) prior to the Whip Test.

#### PREPARATION FOR TEST -

The free length of the hoses to be whip tested shall be measured to within a tolerance of 0.015" with the hose assembly in a straight position using a vernier caliper scale or equivalent. When measuring the free length, the lengths of the end fittings are not included; only the length of the exposed rubber outer cover is measured. Hoses with a free length of less than 8" or more than 24" are not required to be tested.

All external appendages such as chafing collars, removable mounting brackets, date bands and spring guards shall be removed from the brake hose assembly prior to testing on the whip machine. The removed pieces shall be retained for regrouping with each sample until disposal.

The hoses shall be installed on the whip test machine with the slack settings in the table below.

If a whip test failure occurs, prior to removal of the hose from the whip test machine, two photographs, one from above, and one from the side, shall be taken to show that the hose is not twisted. The torque stripe on the hose will be used as an indicator. The photographs shall be kept on file with the chart recordings. Remove failed hose, replace all hose assemblies with new untested hoses, and repeat the test.

## 12. COMPLIANCE TEST EXECUTION....Continued

### TEST -

Apply the 220 to 235 psig water pressure and bleed all hoses and passages to eliminate air pockets and bubbles.

**TABLE - HOSE LENGTHS**

Free Length Between End Fittings, inches	SLACK	
	1/8" hose (3 mm) or less	More than 1/8" hose (3 mm)
8 to 15½, inclusive	1.750"	No Test
Over 15½ to 19, inclusive	1.250"	No Test
Over 19 to 24, inclusive	0.750"	No Test
10 to 15½, inclusive		1.000"

The time duration for the whip test shall be 35 hours at a machine speed of 780 to 800 rpm.

Pressure and RPM vs. Time shall be permanently recorded for this test.

### 12.A.6. - TENSILE STRENGTH TEST - (See Data Sheet H-6)

Hoses numbered 9 thru 12 shall be subjected to this test and Hose #18 shall also be subjected after completion of the Water Absorption Test (H-10).

The tension test consists of subjecting the hose assembly to increasing tensile load in a suitable testing machine until failure occurs, either by -

- (A) Separation of the specimen from the end fittings, OR
- (B) Failure of the hose structure

A tensile testing machine, which conforms to the requirements of ASTM Methods, E4-03, "Standard Practice for Force Verification of Testing

## 12. COMPLIANCE TEST EXECUTION....Continued

Machines," and provided with a recording device to measure the force applied throughout the slow and fast pull tests. A machine of 1,000 lbs. capacity is sufficient. After removal of any hose armor or date bands, etc., the hose assembly fittings shall be attached to the machine by suitable fixtures so that the hose and fittings shall have a straight center line parallel to the direction of the machine pull.

- (A) Conduct the slow pull test by applying tension at a rate of 1" per minute. The assemblies shall withstand a minimum pull of 325 lbs.
- (B) Conduct the fast pull test by applying tension at a rate of 2" per minute. The assemblies shall withstand a minimum pull of 370 lbs.

Load vs. displacement will be permanently recorded.

### 12.A.7. – LOW TEMPERATURE RESISTANCE TEST - (See Data Sheet H-7)

Hose #13 shall be subjected to this test. After removal of any hose armor, date bands, etc., the hose shall be placed in the cold box on a low conductivity material such as wood. A wood mandrel of the size noted below shall be conditioned with the test hose:

HOSE I.D.	MANDREL DIAMETER (+ 0.03", -0")
Less than 1/8"	2.50"
1/8"	3.00"
3/16" and 1/4"	3.50"
Greater than 1/4"	4.00"

The 70 hour test period shall begin when the box recorded temperature stabilizes between -49°F and -54°F. The hoses are to be conditioned in the cold box in a straight position and after 70 hours are to be bent around the mandrel favoring any natural curvature already in the hose. The bending operation shall occur in the cold box.

The hose assembly shall be wrapped around the mandrel 180° by hand at a steady rate in 3 to 5 seconds, using suitable gloves, and holding the hose rather than grasping the end couplings.

## **12. COMPLIANCE TEST EXECUTION....Continued**

After bending and removal from the cold box, inspect the outer rubber cover for cracks. Cut the hose lengthwise to expose the inner liner for its inspection for cracks. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

The Cold Box Temperature vs. Time shall be permanently recorded.

### **12.A.8. – END FITTING CORROSION TEST - (See Data Sheet H-8)**

Hose #14 shall be subjected to this test. Utilize the apparatus described in ASTM B117-03, "Standard Practice for Operating Salt Spray (Fog) Apparatus."

#### **CONSTRUCTION -**

Construct the salt spray chamber so that:

- (A) The construction material does not affect the corrosiveness of the fog.
- (B) The hose assembly is supported or suspended 30° from the vertical and parallel to the principal direction of the horizontal flow of fog through the chamber.
- (C) The hose assembly does not contact any metallic material or any material capable of acting as a wick.
- (D) Condensation which falls from the assembly does not return to the solution reservoir for respraying.
- (E) Condensation from any source does not fall on the brake hose assemblies or the solution collectors.
- (F) Spray from the nozzles is NOT directed directly onto the hose assembly.

#### **PREPARATION -**

- (A) Plug each end of the hose assembly.
- (B) Mix a salt solution five parts by weight of sodium chloride to 95 parts of distilled water, using sodium chloride substantially free of

## 12. COMPLIANCE TEST EXECUTION....Continued

nickel and copper, and containing on a dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent total impurities.

Insure that the solution is free of suspended solids before the solution is atomized.

- (C) After atomization at 95°F (-2° F, +0° F) ensure that the collected solution is in the PH range of 6.5 to 7.2. Make the PH measurements at 77°F.
- (D) Maintain a compressed air supply to the nozzle or nozzles free of oil and dirt and between 10 and 25 psi.

### OPERATION –

Subject the brake hose assembly to the salt spray continuously for 24 hours.

- (A) Regulate the mixture so that each collector will collect from 1 to 2 ml. of solution per hour for each 80 square centimeters of horizontal collecting area.
- (B) Maintain exposure zone temperature at 95°F (-2° F, +0° F).
- (C) Upon completion, remove the salt deposit from the surface of the hoses by washing gently or dipping in clean running water not warmer than 100° F (-2° F, +0° F) and then drying immediately.
- (D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

### INSPECTION –

A brake hose end fitting shall show no base metal corrosion on the end fitting surface except where crimping or the application of labeling information has caused displacement of the protective coating. Salt spray corrosion shall be noted as presence of red rust in the case of coated ferrous couplings or pitting in the case of brass couplings.

## 12.A.9. - OZONE RESISTANCE TEST - (See Data Sheet H-9)



## **12. COMPLIANCE TEST EXECUTION....Continued**

### **PREPARATION -**

Hose #15 shall be subjected to this test.

Remove all hose armor, date bands, etc., and utilizing a cylinder with a diameter eight times the nominal outside diameter of the brake hose, bind the brake hose 360° around the cylinder. In the case of hose shorter than the circumference of the cylinder, bend the hose so that as much of its length as possible is in contact.

### **EXPOSURE TO OZONE -**

- (A) Condition the hose on the cylinder in air at room temperature for 24 hours minimum.
- (B) Immediately thereafter, condition the hose on the cylinder for 70 hours in an exposure chamber having an ambient air temperature of 104° F (-2° F, +0° F) during the test and containing air mixed with ozone in the proportion of 100 parts of ozone per 100 million parts of air by volume.
- (C) Examine the hose for cracks under 7-power magnification, ignoring areas immediately adjacent to or within the area covered by binding. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.
- (D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

## **12.A.10. - WATER ABSORPTION TEST - (See Data Sheets H-10A, H-10B, H-10C)**

Hoses numbered 16 thru 18 shall be subjected to this test.

### **PREPARATION -**

Prepare three (3) hose assemblies and measure the free length of each hose assembly.

### **IMMERSION AND SEQUENCE TESTING -**

Immerse the hose assemblies in distilled water at 185° F (-2° F, +0° F) for 70 hours. Within 30 minutes after removal from the water, the following tests shall be started:

## **12. COMPLIANCE TEST EXECUTION....Continued**

Hose #16 - BURST STRENGTH TEST (Paragraph 12.A.4)

Hose #17 - WHIP TEST (Paragraph 12.A.5)

Hose #18 - TENSILE STRENGTH TEST (Paragraph 12.A.6)

### **12.A.11. - BRAKE FLUID COMPATIBILITY TEST - (See Data Sheet H-11)**

Hose #19 shall be subjected to this test.

#### **PREPARATION -**

- (A) Attach a hose assembly below a 1-pint reservoir filled with 100 ml of SAE RM-66-05 Compatibility Fluid.
- (B) Fill the hose assembly with the compatibility fluid, seal the lower end, and place the test assembly in an oven in a vertical position.

#### **OVEN TREATMENT -**

- (A) Condition the hose assembly at 248°F (-2° F, +0° F) for 70 hours. Temperature vs. Time shall be permanently recorded.
- (B) Cool the hose assembly at room temperature for 30 minutes minimum.
- (C) Drain the fluid from the brake hose and perform the Constriction Test in accordance with Paragraph 12.A.2.
- (D) Immediately following the test above, perform a Burst Strength Test in accordance with Paragraph 12.A.4 (except after the 2-minute hold increase the pressure to 5000 psi for all hose sizes).

### **12.A.12. - HIGH TEMPERATURE IMPULSE TEST - (See Data Sheet H-12)**

#### **APPARATUS –**

- (A) A pressure cycling machine to which one end of the brake hose assembly can be attached, with the entire hose assembly installed vertically inside of a circulating air oven. The machine shall be capable of increasing the pressure in the hose from zero psi to

## 12. COMPLIANCE TEST EXECUTION....Continued

1600 psi, and decreasing the pressure in the hose from 1600 psi to zero psi, within 2 seconds.

- (B) A circulating air oven that can reach a temperature of 295 degrees Fahrenheit within 30 minutes and can maintain 295° F (-2° F, +0° F) thereafter, with the brake hose assembly inside of the oven and attached to the pressure cycling machine.
- (C) A burst test apparatus to conduct testing specified in S6.2.

### PREPARATION -

- (A) Connect one end of the hose assembly to the pressure cycling machine and plug the other end of the hose. Fill the pressure cycling machine and hose assembly with SAE RM-66-05 Compatibility Fluid, as described in Appendix B of SAE Standard J1703 JAN 1995 "Motor Vehicle Brake Fluid," and bleed all gases from the system.
- (B) Place the brake hose assembly inside of the circulating air oven in a vertical position. Increase the oven temperature to 295° F and maintain this temperature (-2° F, +0° F) throughout the pressure cycling test.
- (C) During each pressure cycle, the pressure in the hose is increased from zero psi to 1600 psi and held constant for 1 minute, then the pressure is decreased from 1600 psi to zero psi and held constant for 1 minute. Perform 150 pressure cycles on the brake hose assembly.
- (D) Remove the brake hose assembly from the oven, disconnect it from the pressure cycling machine, and drain the fluid from the hose. Cool the brake hose assembly at room temperature for 45 minutes.
- (E) Wipe the brake hose using acetone to remove residual Compatibility Fluid. Conduct the burst strength test in S6.2, except all sizes of hose are tested at 5,000 psi.

### 12.A.13. - DYNAMIC OZONE TEST (See Data Sheet H-13)

Apparatus - Utilize a test apparatus shown in Figure 6 which is constructed so that:

**12. COMPLIANCE TEST EXECUTION....Continued**

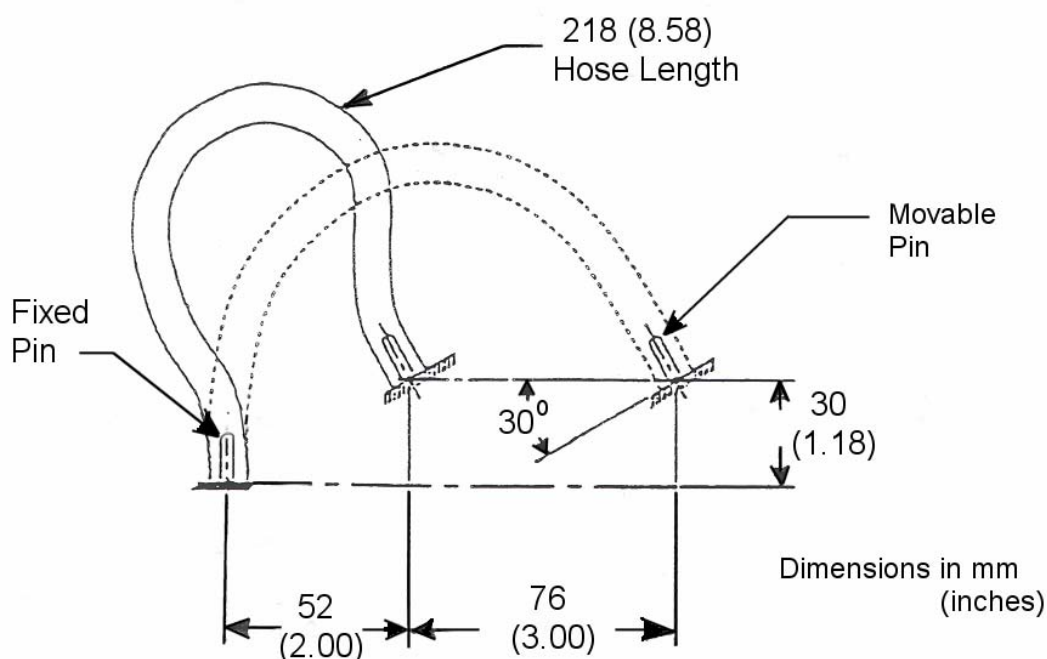
- (A) It has a fixed pin with a vertical orientation over which one end of the brake hose is installed.
- (B) It has a movable pin that is oriented 30 degrees from vertical, with the top of the movable pin angled towards the fixed pin. The moveable pin maintains its orientation to the fixed pin throughout its travel in the horizontal plane. The other end of the brake hose is installed on the movable pin.

**Preparation -**

- (A) Precondition the hose assembly by laying it on a flat surface in an unstressed condition, at room temperature, for 24 hours.
- (B) Cut the brake hose assembly to a length of 8.6 inches (218 mm), such that no end fittings remain on the cut hose.
- (C) Mount the brake hose onto the test fixture by fully inserting the fixture pins into each end of the hose. Secure the hose to the fixture pins using a band clamp at each end of the hose.
- (D) Place the test fixture into an ozone chamber.
- (E) Stabilize the atmosphere in the ozone chamber so that the ambient temperature is 104° F (-2° F, +0° F) and the air mixture contains air mixed with ozone in the proportion of 100 parts of ozone per 100 million parts of air by volume. This atmosphere is to remain stable throughout the remainder of the test.
- (F) Begin cycling the movable pin at a rate of 0.3 Hz. Continue the cycling for 48 hours.
- (G) At the completion of 48 hours of cycling, remove the test fixture from the ozone chamber. Without removing the hose from the test fixture, visually examine the hose for cracks without magnification, ignoring areas immediately adjacent to or within the area covered by the band clamps. Examine the hose with the movable pin at any point along its travel.

## 12. COMPLIANCE TEST EXECUTION....Continued

Figure 6. Dynamic Ozone Test Apparatus



### 12.A.14. - TRACER CORD IDENTIFICATION - (See Data Sheet H-14)

This paragraph is provided for information only to aid in further hose identification, if required, particularly in the event of illegible hose/fitting identification.

All hoses within the group with the exception of the "FAILED" sample shall be subjected to this test. To determine the tracer cord color, carefully

remove one section of the outer rubber cover (approximately 2 inches long and one-half way around the hose) to expose the outer ply of the braid, and identify the color of the tracer cord. Where no tracer cord is present in the outer braid, expose the surface of the inner braid.

## 12. COMPLIANCE TEST EXECUTION....Continued

State the color or colors found and refer to the R.M.A. Code Assignments, "Colored Yarn Manufacturers Identification," to add the name of the hose manufacturer. If no identification is present in either braid, write "NONE" in the space on the data sheet. The R.M.A. Code Assignments may be obtained from the Rubber Manufacturers Association, Inc., 1400 K Street, NW, Washington, DC 20005 (Attention Mr. Stephen Butcher, Telephone Number 202-682-4818).

### B. TEST REQUIREMENTS - AIR BRAKE HOSES

#### 12.B.1. - LABELING INSPECTION - (See Data Sheets A-1A, B & C)

All air hose test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.

The data sheets contain a selection matrix allowing designation of the test specimens as being the following:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

**Vehicle Specific Assemblies** are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

**Aftermarket Assemblies** are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

**Special Test Assemblies** are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine). Markings are NOT required on the **Special Test Assemblies**.

### HOSE MATERIAL MARKING

Although NOT required on hose material of assemblies to be tested, the following hose information shall be recorded if present.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (A) The letters "DOT"
- (B) Hose Manufacturer's Identification
- (C) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).
- (D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing followed by the letters "OD"
- (E) The letters A, AI or All

### END FITTINGS (Non-crimped or Swaged type)

At least one component of any non-crimped or swaged type end fitting shall be marked with the following information.

- (A) The letters "DOT"
- (B) Manufacturer's Identification
- (C) The letters A, AI or All
- (D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing following by the letters "OD"

### HOSE ASSEMBLIES (Crimped or swaged type end fittings)

Hose assemblies with fittings attached by crimping or swaging have two (2) options for marking.

OPTION 1: Marking shall be on a band and shall consist of the following:

- (A) The letters "DOT"
- (B) Manufacturer's identification

OPTION 2: The manufacturer's Identification shall be marked on at least one end fitting hose assemblies with fittings other than crimped or swaged have NO assembly labeling requirements.

## 12. COMPLIANCE TEST EXECUTION....Continued

### 12.B.2. - CONstriction TEST - (See Data Sheet A-2)

All test specimens shall be subjected to this test. This shall be conducted following the same procedure and with the same plug gages as specified previously. The constriction gage shall have a plug maximum diameter as follows: (Same diameter ball or rod is permissible)

0.0820" to 0.0823"	for 1/8" hose	(3.2 mm)
0.1230" to 0.1234"	for 3/16" hose	(4.8 mm)
0.1641" to 0.1646"	for 1/4" hose	(6.3 mm)
0.2051" to 0.2057"	for 5/16" hose	(7.9 mm)
0.2461" to 0.2469"	for 3/8" hose	(9.5 mm)
0.2666" to 0.2674"	for 13/32" hose	(10.3 mm)
0.2870" to 0.2879"	for 7/16" hose	(11.1 mm)
0.3281" to 0.3291"	for 1/2" hose	(12.7 mm)
0.4104" to 0.4115"	for 5/8" hose	(15.9 mm)

NOTE: Hose marked as 3/8 O.D. shall be considered as a 1/4 inch Nominal Inside Diameter (I.D.).

The gage plug maximum diameter used by the test laboratory shall be shown to the nearest ten thousandth of an inch, under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate location of the constriction. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

The brake hose constriction test requirements shall be met using at least one of the methods specified below.

#### Plug gauge

- (A) Utilize a plug gauge as shown in Figure 5. Diameter 'A' is equal to 66 percent of the nominal inside diameter of the hydraulic brake hose being tested.
- (B) Brake hose assemblies that are to be used for additional testing have constriction testing only at each end fitting. Other brake hose assemblies may be cut into three inch lengths to permit constriction testing of the entire assembly. Hose assemblies with end fittings that do not permit entry of the gauge (e.g., restrictive orifice or banjo fitting) are cut three



**12. COMPLIANCE TEST EXECUTION....Continued**

inches from the point at which the hose terminates in the end fitting and then tested from the cut end.

- (C) Hold the brake hose in a straight position and vertical orientation.
- (D) Place the spherical end of the plug gauge just inside the hose or end fitting. If the spherical end will not enter the hose or end fitting using no more force than gravity acting on the plug gauge, this constitutes failure of the constriction test.
- (E) Release the plug gauge. Within three seconds, the plug gauge shall fall under the force of gravity alone up to the handle of the gauge. If the plug gauge does not fully enter the hose up to the handle of the gauge within three seconds, this constitutes failure of the constriction test.

**Extended plug gauge**

- (A) The test in S6.12.1 may be conducted with an extended plug gauge to enable testing of the entire brake hose from one end fitting, without cutting the brake hose. The extended plug gauge weight and spherical diameter specifications are as shown in Figure 5, but the handle portion of the gauge may be deleted and the gauge length may be greater than 3 inches.

## **12. COMPLIANCE TEST EXECUTION....Continued**

- (B) The required performance of the extended plug gauge in paragraph S6.12.1(e) is that after the plug gauge is released, the extended plug gauge shall fall under the force of gravity alone at an average rate of 1 inch per second until the spherical diameter of the extended gauge passes through all portions of the brake hose assembly containing hose. If the extended plug gauge does not pass through all portions of the brake hose assembly containing hose at an average rate of 1 inch per second, this constitutes failure of the constriction test.

### **Drop ball test**

- (A) Utilize a rigid spherical ball with a diameter equal to 66 percent of the nominal inside diameter of the hydraulic brake hose being tested. The weight of the spherical ball shall not exceed 2 ounces (57 grams).
- (B) Hold the brake hose in a straight position and vertical orientation.
- (C) Hold the ball just above the end fitting.
- (D) Release the ball. The ball shall fall under the force of gravity alone completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second. Failure of the ball to pass completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second, constitutes failure of the constriction test.

### **12.B.3. - HIGH TEMPERATURE TEST - (See Data Sheet A-3)**

Hose #1 shall be subjected to this test. Use a cylinder of the diameter noted on the table below for the specific hose diameter being tested.

Secure the test hose around the cylinder and place the assembly in an air oven for 70 hours. Maintain the temperature at 212° F (-2° F, +0° F).

Temperature vs. Time shall be permanently recorded.

Remove the hose and cylinder from the oven and allow to cool to room temperature. Hand straighten the hose and inspect for external cracks, charring or disintegration. Cut the hose lengthwise and inspect internally for any test damage.

**12. COMPLIANCE TEST EXECUTION....Continued**

HOSE NOMINAL I.D. (mm)	TEST CYLINDER RADIUS
3/16" (4,5)	1" (25)
1/4" (6)	1½" (38)
5/16" (8)	1¾"
3/8" (-)	1¾"
13/32" (10)	1 ⅞"
7/16", 1/2" (12)	2"
5/8"	2½"

**12.B.4. – LOW TEMPERATURE RESISTANCE TEST - (See Data Sheet A-4)**

Hose #2 shall be subjected to this test.

After removal of any hose armor, date bands, etc., the hose shall be placed in the cold box on a low conductivity material such as wood. A wood mandrel of the size noted in the table below shall be conditioned with the test hose.

The cold box 70 hour test period shall begin when the box recorded temperature stabilizes at -40° F (-0° F, +2° F). The hose is to be conditioned in the cold box in a straight position and after 70 hours is to be bent around the mandrel favoring any natural curvature already in the hose. The bending operation shall occur in the cold box at -40° F (-0° F, +2° F).

## 12. COMPLIANCE TEST EXECUTION....Continued

HOSE NOMINAL I.D. (mm)	TEST CYLINDER RADIUS
3/16" (4,5)	2" (51)
1/4" (6)	2½" (64)
5/16" (8)	3" (76)
3/8" (-)	3½" (89)
13/32" (10)	3½" (89)
7/16", 1/2" (12)	4" (102)
5/8"	4½" (114)

The hose assembly shall be wrapped 180° around the mandrel by hand at a steady rate in a period of 3 to 5 seconds, using suitable gloves, and holding the hose rather than grasping the end couplings. After bending and removal from the cold box, inspect the outer rubber cover for cracks without magnification.

Allow the hose to warm at room temperature for two hours. Cut away the end fittings and cut through one wall of the hose lengthwise to expose the inner liner for its inspection for cracks. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

The Cold Box Temperature vs. Time shall be permanently recorded.

### 12.B.5. - OIL RESISTANCE TEST - (See Data Sheet A-5)

Hoses numbered 3 thru 5 shall be subjected to this test.

NOTE: A minimum of three (3) hoses must be used for this test.

#### PREPARATION -

Fabricate the three test specimens by cutting blocks 2 inches long and 3/8 of an inch in width, having a thickness of not more than one-sixteenth inch, from the brake hose inner tube and buff the specimens on both faces to ensure smooth surfaces.

## 12. COMPLIANCE TEST EXECUTION....Continued

### MEASUREMENT -

- (A) Weigh each specimen to the nearest milligram in air (W<sub>1</sub>) and in distilled water (W<sub>2</sub>) at room temperature. If wetting is necessary to remove air bubbles, dip the specimen in acetone and thoroughly rinse it with distilled water.
- (B) Immerse each specimen in ASTM IRM 903 oil for 70 hours at 212°F (-2° F, +0° F) and then cool in ASTM IRM 903 oil at room temperature for 30 to 60 minutes.
- (C) Dip the specimen in acetone and blot it lightly with filter paper.
- (D) Weigh each specimen in a tared weighing bottle (W<sub>3</sub>) and in distilled water (W<sub>4</sub>) within 5 minutes of removal from the cooling liquid.
- (E) Calculate the percentage increase in volume as follows:

$$\text{Percent of Increase} = \frac{(W_3 - W_4) - (W_1 - W_2)}{(W_1 - W_2)} \times 100$$

- (F) Enter the data on Data Sheet A-5 and average the three results.

### 12.B.6. - OZONE TEST - (See Data Sheet A-6)

Hose #6 shall be subjected to this test.

### PREPARATION -

Remove all hose armor, date bands, etc., and utilizing a cylinder in accordance with the table below, bind the brake hose 360° around the cylinder. In the case of hose shorter than the circumference of the cylinder, bend the hose so that as much of its length as possible is in contact.

**12. COMPLIANCE TEST EXECUTION....Continued****TABLE I**

<b>HOSE NOMINAL I.D. (mm)</b>	<b>TEST CYLINDER RADIUS</b>
3/16" (4,5)	2" (51)
1/4" (6)	2½" (64)
5/16" (8)	3" (76)
3/8" (-)	3½" (89)
13/32" (10)	3½" (89)
7/16", 1/2" (12)	4" (102)
5/8"	4½" (114)

**EXPOSURE TO OZONE -**

- (A) Condition the hose on the cylinder in air at room temperature for 24 hours minimum.
- (B) Immediately thereafter, condition the hose on the cylinder for 70 hours in an exposure chamber having an ambient air temperature of 104° F (-2° F, +0° F) during the test and containing air mixed with ozone in the proportion of 100 parts of ozone per 100 million parts of air by volume.
- (C) Examine the hose for cracks under 7-power magnification, ignoring areas immediately adjacent to or within the area covered by binding.

An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

- (D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

**12.B.7. - LENGTH CHANGE TEST - (See Data Sheet A-7)**

Hose #7 shall be subjected to this test.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (A) Position a test hose in a straight, horizontal position, and apply air pressure of 9.5 to 10 psig.
- (B) Measure the hose to determine original free length.
- (C) Without releasing the 10 psi, raise the air pressure to the test hose to 195 to 200 psi.
- (D) Measure the hose under 200 psi to determine final free length. An elongation or contraction is an increase or decrease, respectively, in the final free length from the original free length of the hose.

### 12.B.8. - ADHESION TEST (HOSE NOT REINFORCED BY WIRE) - (See Data Sheet A-8)

NOTE: This test shall not be performed on hose stock with internal steel cord.

Hose #8 shall be subjected to this test.

#### APPARATUS -

Utilize a power-driven apparatus of the inclination balance or pendulum type which is constructed so that:

- (A) The recording head includes a freely rotating form with an Outside Diameter (O.D.) substantially the same as Inside Diameter (I.D.) of the hose specimen to be placed on it.
- (B) The freely rotating form is mounted so that its axis of rotation is in the plane of the ply being separated from the specimen and so that the applied force is perpendicular to the tangent of the specimen circumference at the line of separation.
- (C) The rate of travel of the power-actuated grip is a uniform 1 inch per minute and the capacity of the load cell is such that the maximum applied tension during the test is not more than 85 percent nor less than 15 percent of the load cell's rated capacity.
- (D) The machine operates with no device for maintaining maximum load indication, and in a pendulum type machine, the weight lever swings as a free pendulum without engagement of pawls.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (E) The machine produces a chart with inches of separation as one coordinate and applied tension as the other.

### PREPARATION -

- (A) Cut a test specimen of 1 inch or more in length from the hose to be tested and cut the layer to be tested of that test specimen longitudinally along its entire length to the level of contact with the adjacent layer. Record specimen length on data sheet.
- (B) Peel the layer to be tested from the adjacent layer to create a flap large enough to permit attachment of the power-actuated clamp of the apparatus.
- (C) Mount the test specimen on the freely rotating form with the separated layer attached to the power-actuated clamp.

### CALCULATIONS -

- (A) The adhesion value shall be the minimum force recorded on the chart excluding that portion of the chart which corresponds to the initial and final 20 percent portion along the displacement axis.
- (B) Express the force in pounds per inch of length.

## 12.B.9. - FLEX STRENGTH AND AIR PRESSURE TEST - (See Data Sheet A-9)

Hose #9 shall be subjected to this test.

### Apparatus

A flex testing machine with a fixed hose assembly attachment point and a movable hose assembly attachment point, which meets the dimensional requirements of Figure 7 for the size of hose being tested. The attachment points connect to the end fittings on the hose assembly without leakage and, after the hose assembly has been installed for the flex test, are restrained from rotation. The movable end has a linear travel of 6 inches and a cycle rate of 100 cycles per minute. The machine is capable of increasing the air pressure in the hose assembly from zero to



**12. COMPLIANCE TEST EXECUTION....Continued**

150 psi within 2 seconds, and decreasing the air pressure in the hose assembly from 150 to zero psi within 2 seconds.

Preparation.

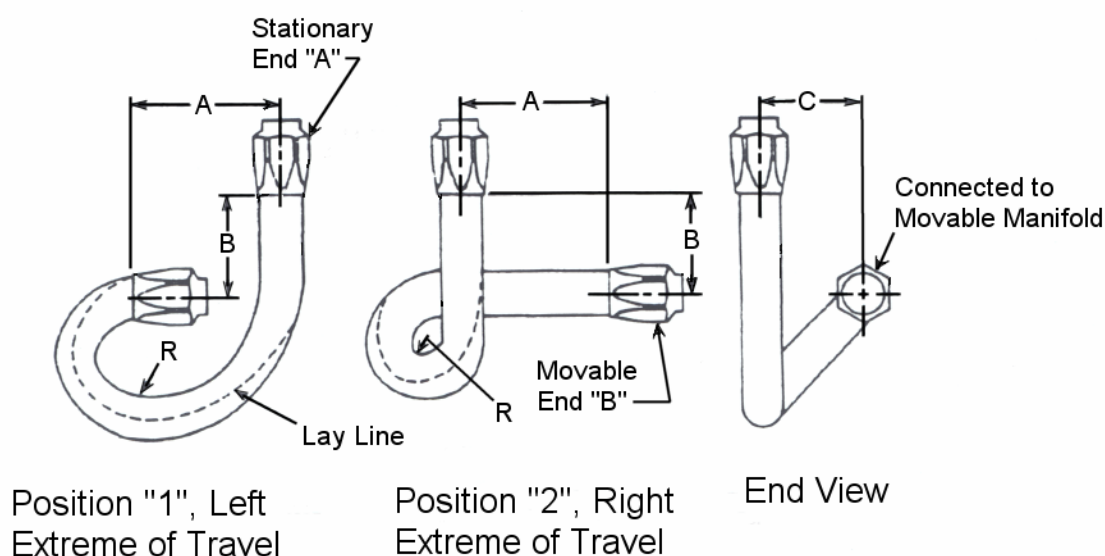
- (A) Lay the hose material on a flat surface in an unstressed condition. Apply a permanent marking line along the centerline of the hose on the uppermost surface.
- (B) Prepare the hose assembly with a free length as shown in the table accompanying Figure 7. The end fittings shall be attached according to the end fitting manufacturer's instructions.
- (C) Plug the ends of the hose assembly and conduct the salt spray test in S6.11 using an air brake hose assembly. Remove the plugs from the end fittings.
- (D) Within 168 hours of completion of the salt spray test, expose the hose assembly to an air temperature of 212<sup>0</sup> F (-2° F, +0° F) for 70 hours, with the hose in a straight position. Remove the hose and cool it at room temperature for 2 hours. Within 166 hours, subject the hose to the flexure test in (e).
- (E) Install the hose assembly on the flex testing machine as follows. With the movable hose attachment point at the mid point of its travel, attach one end of the hose to the movable attachment point with the marked line on the hose in the uppermost position. Attach the other end of the hose to the fixed attachment point allowing the hose to follow its natural curvature.
- (F) Cycle the air pressure in the hose by increasing the pressure in the hose from zero psi to 150 psi and holding constant for one minute, then decreasing the pressure from 150 psi to zero psi and holding constant for one minute. Continue the pressure cycling for the duration of the flex testing. Begin the flex testing by cycling the movable attachment point through 6 inches of travel at a rate of 100 cycles per minute. Stop the flex testing and pressure cycling after 1 million flex cycles have been completed.
- (G) Install an orifice with a hole diameter of 0.0625 inches and a thickness of 0.032 inches in the air pressure supply line to the hose assembly. Provide a gage or other means to measure air pressure

## 12. COMPLIANCE TEST EXECUTION....Continued

in the hose assembly. Regulate the supply air pressure to the orifice to 150 psi.

- (H) Apply 150 psi air pressure to the orifice. After 2 minutes have elapsed, measure the air pressure in the brake hose assembly, while pressurized air continues to be supplied through the orifice.

**Figure 7. Flex Test Apparatus**



Free Hose Length	Nominal Hose Inside Diameter	Dimensions							
		Position "1"				Position "2"			
		A	B	C	R <sup>(1)</sup>	A	B	C	R <sup>(1)</sup>
10.00 (254)	3/16, 1/4	3.00 (76)	2.75 (70)	3.75 (95)	1.40 (34)	3.00 (76)	2.75 (70)	3.75 (95)	1.20 (30)
11.00 (279)	5/16, 3/8, 13/32	3.00 (76)	3.50 (89)	4.50 (114)	1.70 (43)	3.00 (76)	3.50 (89)	4.50 (114)	1.30 (33)
14.00 (355)	7/16, 1/2, 5/8	3.00 (76)	4.00 (102)	5.00 (127)	2.20 (56)	3.00 (76)	4.00 (102)	5.00 (102)	1.80 (46)

Note (1) This is an approximate average radius.

Pressure vs. Time shall be permanently recorded.

### 12.B.10. - CORROSION RESISTANCE AND BURST STRENGTH TEST - (See Data Sheet A-10)

Hose #10 shall be subjected to this test. Conduct the test specified in Paragraph 12.A.8 using an air brake hose assembly.

## 12. COMPLIANCE TEST EXECUTION....Continued

Remove the plugs from the ends of the hose assembly.

Fill the hose assembly with water, allowing all gases to escape. Apply water pressure at a uniform rate of increase of approximately 1,000 psi per minute until the hose ruptures.

Pressure vs. Time shall be permanently recorded.

### 12.B.11. - TENSILE STRENGTH TEST - (See Data Sheet A-11)

Hose #11 shall be subjected to this test and Hose #12 shall also be subjected after completion of the Water Absorption Test (A-12).

The tension test consists of subjecting the hose assembly to increasing tensile load in a suitable testing machine until failure occurs, either by -

- (A) Separation of the specimen from the end fittings, OR
- (B) Failure of the hose structure

A tensile testing machine, which conforms to the requirements of ASTM Methods, E4, "Verification of Testing Machines," shall be used. A machine of 1,000 lbs. capacity is sufficient. After removal of any hose armor or date bands, etc., the hose assembly fittings shall be attached to the machine by suitable fixtures so that the hose and fittings shall have a straight center line parallel to the direction of the machine pull. Tensile pull shall be applied at the rate of  $1" \pm 0.1"$  per minute. The allowable tensile strengths in pounds are shown in the table below.

The tensile machine shall be provided with a recording device such as an X-Y Plotter, to give the total pull (pounds) at the conclusion of the test.

Vehicle Application	ALLOWABLE TENSILE STRENGTH			
	I.D. $\leq \frac{1}{4}"$	I.D. $> \frac{1}{4}"$	$\frac{1}{4}" < \text{I.D.} \leq \frac{1}{2}"$	I.D. $< \frac{1}{2}"$
Between frame and axle	250 lbs	325 lbs	-	-
Other	50 lbs	-	150 lbs	325 lbs

**12. COMPLIANCE TEST EXECUTION....Continued****12.B.12. - WATER ABSORPTION TEST - (See Data Sheet A-12)**

Hose #12 shall be subjected to this test. Immerse the hose in distilled water at room temperature for 70 hours. Within 30 minutes after removal from the water, conduct the Tensile Strength Test in accordance with Paragraph 12.B.11.

**12.B.13. - ZINC CHLORIDE RESISTANCE TEST - (See Data Sheet A-13)**

Hose #13 shall be subjected to this test.

Immerse the hose in a 50 percent zinc chloride aqueous solution at room temperature for 200 hours. Remove it from the solution and examine it

under 7-power magnification for cracks. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

**12.B.14. - SALT SPRAY TEST - (See Data Sheet A-14)**

Hose #14 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.8.

**12.B.15. - ADHESION TEST (HOSE REINFORCED BY WIRE) - (See Data Sheet A-15)**

- (A) Place a steel ball with a diameter equal to 73 percent of the nominal inside diameter of the hose being tested inside of the hose. Plug one end of the hose. Attach the other end of the hose to a source of vacuum.
- (B) Subject the hose to a vacuum of 25 inches of Hg for five minutes. With the vacuum still applied to the hose, bend the hose 180 degrees around a large test cylinder with a radius specified in Table I (Par. 12.B.4) for the size of hose tested. At the location of this bend, bend the hose 180 degrees around the test cylinder in the opposite direction.
- (C) With the vacuum still applied to the hose, return the hose to a straight position. Attempt to roll the ball inside the hose using gravity from one end of the hose to the other end.

## 12. COMPLIANCE TEST EXECUTION....Continued

### 12.B.16. - TRACER CORD IDENTIFICATION - (See Data Sheet A-15)

Perform the identification in accordance with Paragraph 12.A.12.

## C. TEST Requirements - VACUUM BRAKE HOSES

### 12.C.1. - LABELING INSPECTION - (See Data Sheets V-1A, B & C)

All vacuum hose test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.

The data sheets contain a selection matrix allowing designation of the test specimens as being as follows:

**Vehicle Specific Assemblies**  
**Aftermarket Assemblies**  
**Special Test Assemblies**

**Vehicle Specific Assemblies** are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

**Aftermarket Assemblies** are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

**Special Test Assemblies** are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine). Markings are NOT required on the **Special Test Assemblies**.

## HOSE MATERIAL MARKING

Although NOT required on hose material of assemblies to be tested, the following hose information shall be recorded if present.

- (A) The letters "DOT"
- (B) Hose Manufacturer's Identification

**12. COMPLIANCE TEST EXECUTION....Continued**

- (C) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).
- (D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing followed by the letters "OD"
- (E) The letters VL or VH

**END FITTINGS (Reusable fittings only)**

Except for an end fitting that is attached by heat shrinking or by interference fit with plastic vacuum hose or that is attached by deformation of the fitting about a hose by crimping or swaging, at least one component of any end fitting shall be marked with the following information.

- (A) The letters "DOT"
- (B) Manufacturer's Identification
- (C) The letters VL or VH
- (D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing following by the letters "OD"

**HOSE ASSEMBLIES (Nonreusable end fittings only)**

Hose assemblies with nonreusable end fittings have two (2) options for marking.

OPTION 1: Marking shall be on a band and shall consist of the following:

- (A) The letters "DOT"
- (B) Manufacturer's identification

OPTION 2: The manufacturer's Identification shall be marked on at least one end fitting

Hose assemblies with reusable end fittings have NO assembly labeling requirements.

**12.C.2. - CONstriction TEST - (See Data Sheet V-2)**

## 12. COMPLIANCE TEST EXECUTION....Continued

All test specimens shall be subjected to this test. This is basically a "go" or "no go" test in which a plug gage, an extended plug gage, or a drop ball is inserted in the upper end of a hose assembly, which is held vertically, and allowed to drop by gravity through the hose. The hose is acceptable if the gage passes through the hose and can be seen at the lower fitting. Failure to appear at the lower fitting shall be considered a test failure.

The gage plug maximum diameter used by the test laboratory shall be shown under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate location of the constriction. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

The brake hose constriction test requirements shall be met using at least one of the methods specified below.

### **Plug gauge**

- (A) Utilize a plug gauge as shown in Figure 5. Diameter 'A' is equal to 75 percent of the nominal inside diameter of the vacuum brake hose if it is heavy duty, or 70 percent of the nominal inside diameter of the vacuum brake hose if it is light duty.
- (B) Brake hose assemblies that are to be used for additional testing have constriction testing only at each end fitting. Other brake hose assemblies may be cut into three inch lengths to permit constriction testing of the entire assembly. Hose assemblies with end fittings that do not permit entry of the gauge (e.g., restrictive orifice or banjo fitting) are cut three inches from the point at which the hose terminates in the end fitting and then tested from the cut end.
- (C) Hold the brake hose in a straight position and vertical orientation.
- (D) Place the spherical end of the plug gauge just inside the hose or end fitting. If the spherical end will not enter the hose or end fitting using no more force than gravity acting on the plug gauge, this constitutes failure of the constriction test.
- (E) Release the plug gauge. Within three seconds, the plug gauge shall fall under the force of gravity alone up to the handle of the gauge. If the plug gauge does not fully enter the hose up to the handle of the gauge within three seconds, this constitutes failure of the constriction test.

## 12. COMPLIANCE TEST EXECUTION....Continued

### Extended plug gauge

- (A) The test in S6.12.1 may be conducted with an extended plug gauge to enable testing of the entire brake hose from one end fitting, without cutting the brake hose. The extended plug gauge weight and spherical diameter specifications are as shown in Figure 5, but the handle portion of the gauge may be deleted and the gauge length may be greater than 3 inches.
- (B) The required performance of the extended plug gauge in paragraph S6.12.1(e) is that after the plug gauge is released, the extended plug gauge shall fall under the force of gravity alone at an average rate of 1 inch per second until the spherical diameter of the extended gauge passes through all portions of the brake hose assembly containing hose. If the extended plug gauge does not pass through all portions of the brake hose assembly containing hose at an average rate of 1 inch per second, this constitutes failure of the constriction test.

### Drop ball test

- (A) Utilize a rigid spherical ball with a diameter equal to 75 percent of the nominal inside diameter of the vacuum brake hose if it is heavy duty, or 70 percent of the nominal inside diameter of the vacuum brake hose if it is light duty. The weight of the spherical ball shall not exceed 2 ounces (57 grams).
- (B) Hold the brake hose in a straight position and vertical orientation.



**12. COMPLIANCE TEST EXECUTION....Continued**

- (C) Hold the ball just above the end fitting.
- (D) Release the ball. The ball shall fall under the force of gravity alone completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second. Failure of the ball to pass completely through all portions of the brake hose assembly containing hose, at an average rate of 1 inch per second, constitutes failure of the constriction test.

**12.C.3. - HIGH TEMPERATURE RESISTANCE TEST - (See Data Sheet V-3)**

- (A) Measure the initial outside diameter of the hose.
- (B) Subject the hose to an internal vacuum of 26 inches of Hg at an ambient temperature of 257<sup>0</sup> F (-2° F, +0° F) for a period of 96 hours. Remove the hose to room temperature and atmospheric pressure.
- (C) Within 5 minutes of completion of the conditioning in (b), measure the outside diameter at the point of greatest collapse and calculate the percentage collapse based on the initial outside diameter.
- (D) Cool the hose at room temperature for 5 hours. Bend the hose around a mandrel with a diameter equal to five times the initial outside diameter of the hose. Examine the exterior of the hose for cracks, charring, or disintegration visible without magnification. Remove the hose from the mandrel.
- (E) Fill the hose assembly with water, allowing all gases to escape. Apply water pressure in the hose of 175 psi within 10 seconds. Maintain an internal hydrostatic pressure of 175 psi for one minute and examine the hose for visible leakage.

**12.C.4. - LOW TEMPERATURE RESISTANCE TEST - (See Data Sheet V-4)**

Hose #2 shall be subjected to this test.

- (A) Conduct the test specified in S8.2 (a) through (c) using vacuum brake hose and with the cylinder radius specified in Table II (Par. 12.C.8) for the size of hose tested.
- (B) Remove the hose from the test cylinder, warm the hose at room temperature for 5 hours, and conduct the hydrostatic pressure test in 10.1(e).

## **12. COMPLIANCE TEST EXECUTION....Continued**

### **12.C.5. - OZONE TEST - (See Data Sheet V-5)**

Hose #3 shall be subjected to this test. Perform this test in accordance with Paragraph 12.A.9.

### **12.C.6. - BURST STRENGTH TEST - (See Data Sheet V-6)**

Hose #4 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.4 except that the minimum allowable burst strength shall be 350 psig.

### **12.C.7. - VACUUM TEST - (See Data Sheet V-7)**

Hose #5 shall be subjected to this test, and Hose #7 shall also be subjected after completion of the Swell Test (V-9), utilizing a 12-inch long vacuum brake hose assembly sealed at one end, as follows:

- (A) Measure the hose Outside Diameter (O.D.).
- (B) Attach the hose to a source of vacuum and subject it to a vacuum of 25 to 26 inches of Hg for 5 minutes.
- (C) Measure the hose to determine the minimum outside diameter while the hose is still subject to vacuum.

### **12.C.8. - BEND TEST - (See Data Sheet V-8)**

Hose #6 shall be subjected to this test.

- (A) Bend a vacuum brake hose, of the length prescribed in Table II (shown below), in the direction of its normal curvature until the ends just touch as shown in Figure 3 of FMVSS 106.
- (B) Measure the outside diameter of the specimen at point A before and after bending.
- (C) The difference between the two measurements is the collapse of the hose Outside Diameter on bending. The allowable maximum collapse is shown in the table below.

## 12. COMPLIANCE TEST EXECUTION....Continued

TABLE II - VACUUM BRAKE HOSE TEST REQUIREMENTS							
Hose Inside Dia. (I.D.)	High Temperature Resistance		High Temperature Resistance		Bend		Deformation-Collapsed Inside Dia. (Dimen. D)
	Hose Length	Dia. of Cylinder (+.03,-0)	Hose Length	Dia. of Cylinder (+.03,-0)	Hose Length	Max. Collapse of Outside Dia. (O.D.)	
7/32"	8"	3"	17.5"	6"	7"	11/64"	3/64"
1/4"	9"	3"	17.5"	6"	8"	3/32"	1/16"
9/32"	9"	3.5"	19"	7"	9"	12/64"	4/64"
11/32"	9"	3.5"	19"	7"	11"	13/64"	5/64"
3/8"	10"	3.5"	19"	7"	12"	5/32"	3/32"
15/32"	11"	4"	20.5"	8"	14"	17/64"	5/64"
1/2"	11"	4"	20.5"	8"	16"	7/32"	1/8"
5/8"	12"	4.5"	22"	9"	22"	7/32"	5/32"
3/4"	14"	5"	24"	10"	28"	7/32"	3/16"
1"	16"	6.5"	28.5"	13"	36"	9/32"	1/4"

### 12.C.9. - SWELL AND ADHESION TEST - (See Data Sheet V-10)

Hose #8 shall be subjected to this test.

- (A) Fill a specimen of vacuum brake hose 12 inches long with ASTM Reference Fuel B as described in ASTM D471-98e<sup>1</sup> Standard Test Method for Rubber Property - Effect of Liquids.
- (B) Maintain reference fuel in the hose under atmospheric pressure at room temperature for 48 hours.
- (C) Remove fuel and conduct the constriction test in S10.10.
- (D) Attach the hose to a source of vacuum and subject it to a vacuum of 26 inches of Hg for 10 minutes. Remove the hose from the vacuum source.

**12. COMPLIANCE TEST EXECUTION....Continued**

- (E) For a vacuum brake hose constructed of two or more layers, conduct the test specified in S8.6 using the vacuum brake hose.

**12.C.11. - DEFORMATION TEST - (See Data Sheet V-11)**

Hose #9 shall be subjected to this test. The vacuum brake hose shall return to 90 percent of its original outside diameter within 60 seconds after five applications of force as specified herein. In the case of heavy-duty hose the first application of force shall not exceed a peak value of 70 pounds, and the fifth application of force shall reach a peak value of at least 40 pounds. In the case of light-duty hose the first application of force shall not exceed a peak value of 50 pounds, and the fifth application of force shall reach a peak value of at least 20 pounds. The table below specifies the test specimen dimensions.

**APPARATUS -**

Utilize a compression device, equipped to measure force of at least 100 pounds, and feeler gages of sufficient length to be passed completely through the test specimens.

**OPERATION -**

- (A) Position the test specimen longitudinally in the compression device with the fabric laps not in the line of the applied pressure.
- (B) Apply gradually increasing force to the test specimen to compress its Inside Diameter to that specified in the table below (dimension D of Figure 8) for the size of hose tested.
- (C) After 5 seconds release the force and record the peak load applied.
- (D) Repeat the procedure four times permitting a 10-second recovery period between load applications.

## 12. COMPLIANCE TEST EXECUTION....Continued

FIGURE. 8 - DEFORMED SPECIMEN OF VACUUM BRAKE HOSE

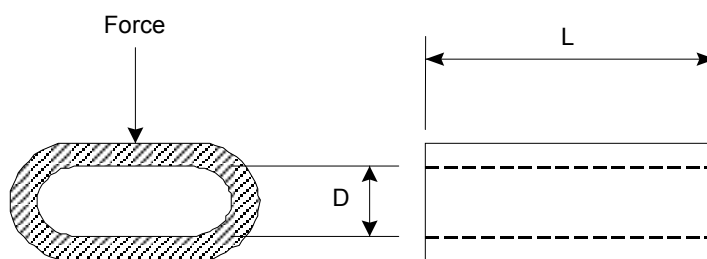


TABLE - DIMENSIONS OF TEST SPECIMEN AND FEELER GAGE FOR DEFORMATION TEST				
Inside Dia. (I.D.) Of Hose	Specimen Dimensions (see Figure 8)		Feeler Gage Dimensions	
	"D" Dimension	"L" Dimension	Width	Thickness
7/32"	3/64"	1"	1/8"	3/64"
1/4"	1/16"	1"	1/8"	1/16"
9/32"	1/16"	1"	1/8"	1/16"
11/32"	5/64"	1"	3/16"	5/64"
3/8"	3/32"	1"	3/16"	3/32"
15/32"	5/64"	1"	1/4"	5/64"
1/2"	1/8"	1"	1/4"	1/8"
5/8"	5/32"	1"	1/4"	5/32"
3/4"	3/16"	1"	1/4"	3/16"
1.0"	1/4"	1"	1/4"	1/4"

## **12. COMPLIANCE TEST EXECUTION....Continued**

### **12.C.12. - SALT SPRAY TEST - (See Data Sheet V-12)**

Hose #10 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.8.

### **12.C.13. - TRACER CORD IDENTIFICATION - (See Data Sheet V-13)**

Perform the identification in accordance with Paragraph 12.A.12.

## **D. TEST REQUIREMENTS – PLASTIC AIR BRAKE TUBING**

### **12.D.1. - LABELING INSPECTION - (See Data Sheets A-1A, B & C)**

All air brake tubing test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded. The data sheets contain a selection matrix allowing designation of the test specimens as being the following:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

**Vehicle Specific Assemblies** are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

**Aftermarket Assemblies** are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

**Special Test Assemblies** are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine). Markings are NOT required on the **Special Test Assemblies**.

### **AIR BRAKE TUBING MATERIAL MARKING**

Although NOT required on tubing material of assemblies to be tested, the following hose information shall be recorded if present.

**12. COMPLIANCE TEST EXECUTION....Continued**

- (A) The letters "DOT"
- (B) Hose Manufacturer's Identification
- (C) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).
- (D) Nominal Outside Hose Diameter (O.D. in inches or mm) of plastic tubing followed by the letters "OD"
- (E) The letter "A"

**END FITTINGS (Non-crimped or Swaged type)**

At least one component of any non-crimped or swaged type end fitting shall be marked with the following information.

- (A) The letters "DOT"
- (B) Manufacturer's Identification
- (C) The letter "A"
- (D) Nominal Outside Diameter (O.D. in inches or mm) of plastic tubing following by the letters "OD"

**HOSE ASSEMBLIES (Crimped or swaged type end fittings)**

Air brake tubing assemblies with fittings attached by crimping or swaging have two (2) options for marking.

OPTION 1: Marking shall be on a band and shall consist of the following:

- (A) The letters "DOT"
- (B) Manufacturer's identification

OPTION 2: The manufacturer's Identification shall be marked on at least one end fitting

Air brake tubing assemblies with fittings other than crimped or swaged have NO assembly labeling requirements.

## 12. COMPLIANCE TEST EXECUTION....Continued

### 12.D.2. – CONSTRICTION TEST – (See Data Sheet P-2)

All test specimens shall be subjected to this test. This is basically a "go" or "no go" test in which a plug gage, an extended plug gage, or a drop ball is inserted in the upper end of an air brake tubing assembly, which is held vertically, and allowed to drop by gravity through the tubing. The air brake tubing is acceptable if the gage passes through the tubing and can be seen at the lower fitting. Failure to appear at the lower fitting shall be considered a test failure.

The constriction gage shall have a minimum diameter as follows (same diameter ball or rod is permissible):

. 0.079" for 1/8" I.D. hose (2.048 mm for 3.2 mm I.D.)

0.119" for 3/16" I.D. hose (3.072 mm for 4.8 mm I.D.)

. 0.159" for 1/4" I.D. hose (4.032 mm for 6.3 mm I.D.)

The gage plug maximum diameter used by the test laboratory shall be shown under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate location of the constriction. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

The brake tubing constriction test requirements shall be met using at least one of the methods specified below.

#### Plug gauge

- (A) Utilize a plug gauge as shown in Figure 5. Diameter 'A' is equal to tested.
- (B) Brake tubing assemblies that are to be used for additional testing have constriction testing only at each end fitting. Other brake tubing assemblies may be cut into three inch lengths to permit constriction testing of the entire assembly. Air brake tubing assemblies with end fittings that do not permit entry of the gauge (e.g., restrictive orifice or banjo fitting) are cut three inches from the



**12. COMPLIANCE TEST EXECUTION....Continued**

point at which the tubing terminates in the end fitting and then tested from the cut end.

- (C) Hold the brake tubing in a vertical orientation.
- (D) Place the spherical end of the plug gauge just inside the tubing or end fitting. If the spherical end will not enter the air brake tubing or end fitting using no more force than gravity acting on the plug gauge, this constitutes failure of the constriction test.
- (E) Release the plug gauge. Within three seconds, the plug gauge shall fall under the force of gravity alone up to the handle of the gauge. If the plug gauge does not fully enter the air brake tubing up to the handle of the gauge within three seconds, this constitutes failure of the constriction test.

**Extended plug gauge**

- (A) The constriction test may be conducted with an extended plug gauge to enable testing of the entire brake air brake tubing from one end fitting, without cutting the brake tubing. The extended plug gauge weight and spherical diameter specifications are as shown in Figure 5, but the handle portion of the gauge may be deleted and the gauge length may be greater than 3 inches.
- (B) The required performance of the extended plug gauge in paragraph S6.12.1(e) is that after the plug gauge is released, the extended plug gauge shall fall under the force of gravity alone at an average rate of 1 inch per

## 12. COMPLIANCE TEST EXECUTION....Continued

second until the spherical diameter of the extended gauge passes through all portions of the brake tubing assembly containing plastic tubing. If the extended plug gauge does not pass through all portions of the brake tubing assembly containing plastic tubing at an average rate of 1 inch per second, this constitutes failure of the constriction test.

### Drop ball test

- (A) Utilize a rigid spherical ball with a diameter equal to 66 percent of the nominal inside diameter of the hydraulic brake tubing being tested. The weight of the spherical ball shall not exceed 2 ounces (57 grams).
- (B) Hold the brake tubing in a vertical orientation.
- (C) Hold the ball just above the end fitting.
- (D) Release the ball. The ball shall fall under the force of gravity alone completely through all portions of the brake tubing assembly containing plastic tubing, at an average rate of 1 inch per second. Failure of the ball to pass completely through all portions of the brake tubing assembly containing tubing, at an average rate of 1 inch per second, constitutes failure of the constriction test.

### 12.D.3. - HIGH TEMPERATURE CONDITIONING AND DIMENSIONAL STABILITY TEST - (See Data Sheet P- 3)

- (A) Condition the tubing at 230° F (-2° F, +0° F) for 4 hours in an air oven.
- (B) Remove the tubing from the oven and allow to cool at room temperature for 30 minutes.
- (C) Measure the tubing dimensions including wall thickness, inside diameter and outside diameter, using appropriate metrology apparatus such as micrometers, dial indicators and gauges, or optical comparators. To account for slight out-of-round conditions, diameter measurements may be calculated using the average of the major and minor diameters.

### 12.D.4. – BOILING WATER CONDITIONING AND DIMENSIONAL STABILITY TEST - (See Data Sheet P- 4)

- (A) Utilize a container constructed of a non-reactive material, large enough so that the tubing to be tested does not touch any surface of the container. Fill container with distilled water.
- (B) Slip the tubing over a stainless steel wire for positioning it in the container.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (E) Bring the water to a boil. Place the tubing in the water and position it so that it does not touch the container. Boil the tubing for two hours. Replenish the water as necessary, adding it slowly so that the water in the container boils continuously.
- (D) Remove the tubing from the water and allow to cool at room temperature for 30 minutes. Wipe off any water that remains on the tubing.
- (E) Measure the tubing dimensions including wall thickness, inside diameter, and outside diameter, using appropriate metrology apparatus such as micrometers, dial indicators and gauges, or optical comparators. To account for slight out-of-round conditions, diameter measurements may be calculated using the average of the major and minor diameters.

### 12.D.5. – BURST STRENGTH TEST - (See Data Sheet P- 5)

- (A) Utilize an air brake tubing assembly or prepare a 12 inch length of tubing and install end fittings according to the end fitting manufacturer's instructions.
- (B) Plug one end of the assembly, fill it with water, and connect the other end to a source of water pressure. Bleed any air from the assembly and water pressure system.
- (C) Increase the water pressure inside the tubing assembly at a rate of 3,000 psi per minute to the burst strength pressure for the size of tubing being tested as specified in Table III.

### 12.D.6. – MOISTURE ABSORPTION AND BURST STRENGTH TEST - (See Data Sheet P-6)

- (A) Prepare a sample of tubing twelve inches in length.
- (B) Condition the tubing at 230° F (-2° F, +0° F) for 24 hours in an air oven. Remove the tubing from the oven and within 30 seconds, weigh it to establish the initial weight. The weight shall be measured with a resolution of 0.01 gram; if the scale has a higher resolution, then values of 0.005 gram and above shall be rounded to the nearest 0.01 gram and values below 0.005 gram shall be truncated.
- (C) Place the tubing in an environmental chamber and condition it for 100 hours at 100% relative humidity and a temperature of 75° F (-2° F, +0° F).
- (D) Remove the tubing from the chamber and within a period of 5 minutes, remove all surface moisture from the tubing using cloth and weigh the

## 12. COMPLIANCE TEST EXECUTION....Continued

tubing to establish the conditioned weight. Weight shall be measured to the nearest 0.01 gram as in (b) above.

- (E) Calculate percentage of moisture absorption as follows:  

$$\frac{[\text{Conditioned Weight} - \text{Initial Weight}]}{[\text{Initial Weight}]} \times 100$$
- (F) Install end fittings according to the end fitting manufacturers instructions.
- (G) Conduct the burst strength test in 12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in Table III.

### 12.D.7. – UV LIGHT RESISTANCE TEST - (See Data Sheet P- 7)

- (A) Apparatus. An accelerated weathering test machine for ultraviolet light conditioning of plastic air brake tubing. The machine shall be equipped with fluorescent UVA-340 light bulbs and automatic irradiance control. Also utilize an impact test apparatus as shown in Figure 9.
- (B) Test Standards. The testing is in accordance with American Society for Testing and Materials (ASTM) G154-00 Standard Practice for Operating Light Apparatus for UV Exposure of Nonmetallic Materials; ASTM G151-00 Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources, and; ASTM D4329-99 Standard Practice for Fluorescent UV Exposure of Plastics.
- (C) Preparation.
  - (i) Utilize a 12-inch length of plastic air brake tubing. Mask 1 inch of each end of the tubing where end fittings will be attached using opaque tape.
  - (ii) Attach the tubing to the test racks of the machine, securing it at the ends along the masked sections. Wipe the outside surface of the tubing with acetone to remove any surface contaminants. Place the tubing and racks in the accelerated weathering test machine so that the center of the tubing assembly is approximately in the center of the UV light exposure area of the test machine. (If multiple plastic brake tubing assemblies are tested, then their position in the machine should be rotated according to ASTM D4329-99 S7.4.1, except the rotation shall be each 96 hours instead of weekly.) The distance from the light bulb to the tubing shall be approximately 2 inches. Set the UV irradiance to 0.85 watts per square meter @ 340 nanometers and maintain this level during the testing. Maintain a temperature in the test chamber of 113° F (-2° F, +0° F), and use

## 12. COMPLIANCE TEST EXECUTION....Continued

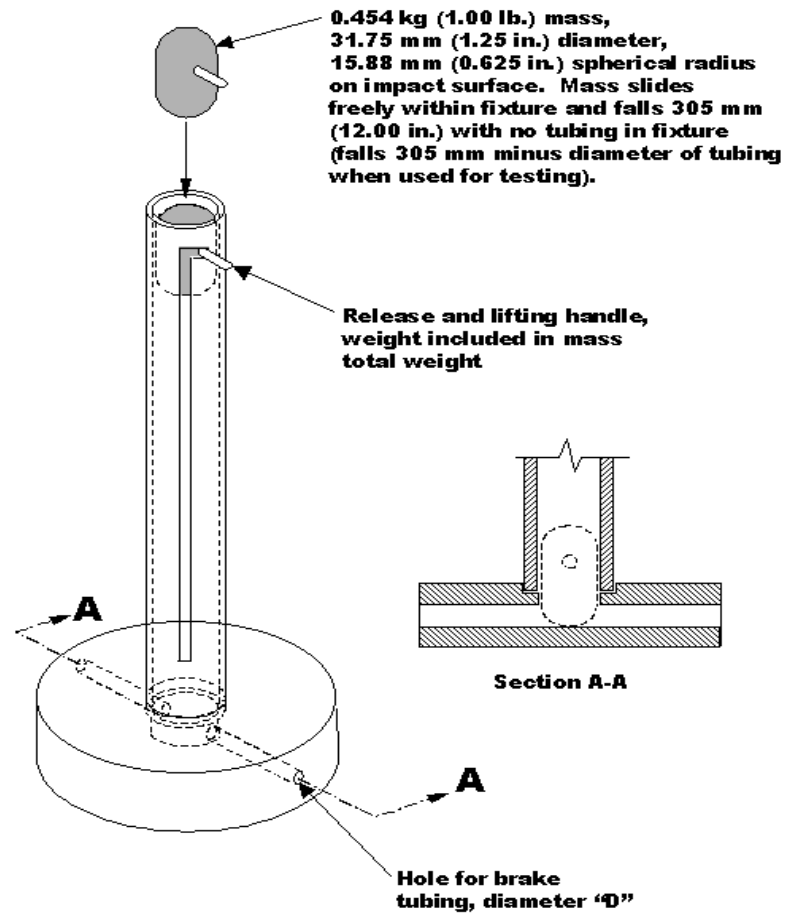
only atmospheric humidity. Expose the tubing at this UV irradiance level for 300 hours continuously. Remove the tubing from the test chamber.

- (iii) Place the tubing inside the impact test apparatus, and drop the impacter onto the tubing from a height of 12 inches.
- (iv) Remove the masking material from the ends of the tubing. Install end fittings according to the end fitting manufacturer's instructions. Conduct the burst strength test in S12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in the table below.

TABLE ACCOMPANYING FIGURE 9		
Nominal Tubing Outside Diameter	Hole Diameter "D"	
	mm	Inches
1/8 inch	3.96	0.156
5/32 inch	4.75	0.187
3/16 inch	5.54	0.218
1/4 inch	7.14	0.281
5/16 inch	8.71	0.343
3/8 inch	10.31	0.406
1/2 inch	13.49	0.531
5/8 inch	16.66	0.656
3/4 inch	20.32	0.800
6 mm	6.80	0.268
8 mm	8.80	0.346
10 mm	10.80	0.425
12 mm	12.80	0.504
16 mm	16.80	0.661

## 12. COMPLIANCE TEST EXECUTION....Continued

Figure 9. Impact Test Apparatus



## **12. COMPLIANCE TEST EXECUTION....Continued**

### **12.D.8. – LOW TEMPERATURE FLEXIBILITY TEST - (See Data Sheet P- 8)**

- (A) Utilize a cylinder having a radius of six times the nominal outside diameter of the tubing.
- (B) Condition the tubing in an air oven at 230° F (-2° F, +0° F) for 24 hours. Remove from the oven and cool at room temperature for 30 minutes.
- (C) Condition the cylinder and the tubing in an environmental chamber at minus 40° F (-0° F, +2° F) for four hours.
- (D) With the tubing and test cylinder at minus 40° F (-0° F, +2° F), bend the tubing 180 degrees around the cylinder at a steady rate in a period of 4 to 8 seconds.

### **12.D.9. – HIGH TEMPERATURE FLEXIBILITY TEST - (See Data Sheet P- 9)**

- (A) Utilize a cylinder having a radius equal to the supported bend radius in Table III for the size of tubing being tested.
- (B) Bend the tubing 180 degrees around the cylinder and hold in place with a clamp or other suitable support, applying only enough force on the tubing to hold it in position.
- (C) Condition the tubing and cylinder in an air oven at 230° F (-2° F, +0° F) for 72 hours. Remove the tubing and cylinder from the oven and cool at room temperature for two hours.
- (D) Remove the clamps or supports from the tubing and straighten the tubing at a steady rate in a period of 4 to 8 seconds.
- (E) Rebend the tubing 180 degrees around the cylinder, at the same point but in the opposite direction of the bending in (b) above, at a steady rate in a period of 4 to 8 seconds.
- (F) Conduct the burst strength test in S12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in Table III.

### **12.D.10. – HIGH TEMPERATURE RESISTANCE TEST - (See Data Sheet P- 10)**

Condition the tubing in an air oven at 230° F (-2° F, +0° F) for 72 hours. Remove the tubing and allow to cool at room temperature for 30 minutes. Conduct the burst strength test in S12.5 except use 80 percent of the

## **12. COMPLIANCE TEST EXECUTION....Continued**

burst strength pressure for the size of tubing being tested as specified in Table III.

### **12.D.11. – HIGH TEMPERATURE CONDITIONING, LOW TEMPERATURE IMPACT RESISTANCE TEST - (See Data Sheet P- 11)**

- (A) Utilize an impact test apparatus as shown in Figure 9.
- (B) Condition the tubing in an air oven at 230° F (-2° F, +0° F) for 72 hours. Remove the tubing and allow to cool at room temperature for 30 minutes.
- (C) Condition the tubing and the impact test apparatus in an environmental chamber at minus 40° F (-0° F, +2° F) for 4 hours.
- (D) With the tubing and impact test apparatus at minus 40° F (-0° F, +2° F), place the tubing inside the apparatus and drop the impacter onto the tubing from a height of 12 inches. Remove the tubing from the chamber and allow to warm at room temperature for one hour.
- (E) Conduct the burst strength test in S12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in Table III

### **12.D.12. – BOILING WATER CONDITIONING, LOW TEMPERATURE IMPACT RESISTANCE TEST - (See Data Sheet P- 12)**

- (A) Utilize an impact test apparatus as shown in Figure 9.
- (B) Condition the tubing in boiling water using the test in S12.4 (a) through (d), except that the length of tubing shall be 12 inches.
- (C) Condition the tubing and the impact test apparatus in an environmental chamber at minus 40° F (-0° F, +2° F) for 4 hours.
- (D) With the tubing and impact test apparatus at minus 40° F (-0° F, +2° F), place the tubing inside the apparatus and drop the impacter onto the tubing from a height of 12 inches. Remove the tubing from the chamber and allow to warm at room temperature for one hour.
- (F) Conduct the burst strength test in S12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in Table III.



## **12. COMPLIANCE TEST EXECUTION....Continued**

### **12.D.13. – ZINC CHLORIDE RESISTANCE TEST - (See Data Sheet P- 13)**

- (A) Utilize a cylinder having a radius equal to the supported bend radius in Table III for the size of tubing being tested. The cylinder is constructed of a non-reactive material or coated to prevent chemical reaction with zinc chloride. The length of the tubing sample is long enough so that its ends will not be submerged during the immersion in zinc chloride, or the ends of the tubing are plugged to keep the zinc chloride from entering the tubing.
- (B) Bend the tubing 180 degrees around the cylinder and hold in place with a clamp or other suitable support constructed of non-reactive materials, applying only enough force on the tubing to hold it in position.
- (C) Immerse the tubing and cylinder in a 50 percent zinc chloride aqueous solution at room temperature for 200 hours.
- (D) Remove the tubing and cylinder from the solution. While still on the test cylinder, inspect the tubing under 7-power magnification for cracks.

### **12.D.14. – METHYL ALCOHOL RESISTANCE TEST - (See Data Sheet P- 14)**

- (A) Utilize a cylinder having a radius equal to the supported bend radius in the table below for the size of tubing being tested. The cylinder is constructed of a non-reactive material or coated to prevent chemical reaction with methyl alcohol.
- (B) Bend the tubing 180 degrees around the cylinder and hold in place with a clamp or other suitable support constructed of non-reactive materials, applying only enough force on the tubing to hold it in position. The ends of the tubing may be shortened so that they will be fully submerged in the methyl alcohol.
- (C) Immerse the tubing and cylinder in a 95 percent methyl alcohol aqueous solution at room temperature for 200 hours.
- (D) Remove the tubing and cylinder from the solution. While still on the test cylinder, inspect the tubing under 7-power magnification for cracks.

## 12. COMPLIANCE TEST EXECUTION....Continued

TABLE III - PLASTIC AIR BRAKE TUBING MECHANICAL PROPERTIES

Nominal Tubing OD	Burst Strength Pressure		Supported Bend Radius <sup>1</sup>		Unsupported Bend Radius <sup>2</sup>		Conditioned Tensile Load	
	kPa	Psi	mm	inches	mm	inches	N	lbf
1/8 inch	6900	1000	9.4	0.37	9.4	0.37	156	35
5/32 inch	8300	1200	12.7	0.50	12.7	0.50	178	40
3/16 inch	8300	1200	19.1	0.75	19.1	0.75	222	50
1/4 inch	8300	1200	25.4	1.00	25.4	1.00	222	50
5/16 inch	6900	1000	31.8	1.25	38.1	1.50	334	75
3/8 inch	9700	1400	38.1	1.50	38.1	1.50	667	150
1/2 inch	6600	950	50.8	2.00	63.5	2.50	890	200
5/8 inch	6200	900	63.5	2.50	76.2	3.00	1446	325
3/4 inch	5500	800	76.2	3.00	88.9	3.50	1557	350
6 mm	7600	1100	20.0	0.75	25.4	1.00	222	50
8 mm	6200	900	31.8	1.25	38.1	1.50	334	75
10 mm	8200	1200	38.1	1.50	38.1	1.50	667	150
12 mm	6900	1000	44.5	1.75	63.5	2.50	890	200
16 mm	6000	875	69.9	2.75	76.2	3.00	1446	325

Notes: (1) Supported bend radius for tests specifying cylinders around which the tubing is bent.

(2) Unsupported bend radius for the collapse resistance test in which the tubing is not supported by a cylinder during bending.

### 12.D.15. – HIGH TEMPERATURE CONDITIONING AND COLLAPSE RESISTANCE TEST - (See Data Sheet P- 15)

#### (A) APPARATUS

A holding device consisting of two vertical pins affixed to a flat, horizontal plate. Each pin projects 1 inch above the top surface of the plate. The diameter of each pin is approximately equal to the inside diameter of the tubing being tested. Using the unsupported bend radius for the size of tubing being tested from Table III, the distance between the pin centerlines is equal to:

$$[2 \times \text{unsupported bend radius}] + [\text{nominal OD of tubing}]$$

#### (B) PREPARATION

- (i) Use the unsupported bend radius for the size of tubing being tested from Table III and cut the tubing to the following length:

## 12. COMPLIANCE TEST EXECUTION....Continued

[3.14 x [unsupported bend radius]] + [10 x [nominal tubing OD]] + 2 inches  
OR [3.14 x [unsupported bend radius]] + [10 x [nominal tubing OD]] + 50 mm

(ii) Place a reference mark at the center of the sample. At this mark, measure the initial outside diameter of the tubing. If the tubing is slightly out-of-round, use the elliptical minor diameter as the initial outside diameter.

(iii) Install the tubing completely over the pins of the holding device so that the tubing is bent 180 degrees. If the tubing has a natural curvature, the tubing shall be bent in the direction of the natural curvature.

(iv) Condition the holding device and tubing in an air oven at 230° F (-2° F, +0° F) for 24 hours. Remove the holding device and tubing and allow to cool at room temperature for thirty minutes.

(v) With the tubing still mounted to the holding device, measure the elliptical minor diameter of the tubing at the reference mark to determine the final outside diameter.

### (C) CALCULATION

Calculate the percentage collapse of the outside diameter of the tubing as follows:

$$[[\text{Initial Outside Diameter} - \text{Final Outside Diameter}] / [\text{Initial Outside Diameter}]] \times 100$$

## 12.D.16. - OZONE RESISTANCE TEST - (See Data Sheet P- 16)

### PREPARATION -

Remove all armor, date bands, etc., and utilizing a cylinder with a diameter eight times the nominal outside diameter of the brake tubing, bind the brake tubing 360° around the cylinder. In the case of tubing shorter than the circumference of the cylinder, bend the tubing so that as much of its length as possible is in contact.

### EXPOSURE TO OZONE -

(A) Condition the tubing on the cylinder in air at room temperature for 24 hours minimum.

## 12. COMPLIANCE TEST EXECUTION....Continued

- (B) Immediately thereafter, condition the tubing on the cylinder for 70 hours in an exposure chamber having an ambient air temperature of 104°F (-2° F, +0° F) during the test and containing air mixed with ozone in the proportion of 100 parts of ozone per 100 million parts of air by volume.
- (C) Examine the tubing for cracks under 7-power magnification, ignoring areas immediately adjacent to or within the area covered by binding. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.
- (D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

### 12.D.17. – OIL RESISTANCE TEST - (See Data Sheet P- 17)

- (A) Utilize a plastic air brake tubing assembly or prepare a 12 inch length of tubing and install end fittings according to the end fitting manufacturer's instructions.
- (B) Immerse the tubing assembly in ASTM 903 oil at 200° F (-2° F, +0° F) for 70 hours. Remove and allow to cool at room temperature for 30 minutes. Wipe any excess oil from the tubing assembly.
- (C) Conduct the burst strength test in S12.5 except use 80 percent of the burst strength pressure for the size of tubing being tested as specified in Table III and, at the manufacturer's option, oil may be used as the test medium instead of water.

### 12.D.18. - TENSILE STRENGTH TEST - (See Data Sheet P- 18)

Air brake tubing numbered 9 thru 12 shall be subjected to this test and Air brake tubing #18 shall also be subjected after completion of the Water Absorption Test (H-10).

The tension test consists of subjecting the tubing assembly to increasing tensile load in a suitable testing machine until failure occurs, either by -

- (A) Separation of the specimen from the end fittings, OR
- (B) Failure of the air brake tubing structure

A tensile testing machine, which conforms to the requirements of ASTM Methods, E4-03, "Standard Practice for Force Verification of Testing Machines," and provided with a recording device to measure the force applied throughout the

## 12. COMPLIANCE TEST EXECUTION....Continued

slow and fast pull tests. A machine of 1,000 lbs. capacity is sufficient. After removal of any air brake tubing armor or date bands, etc., the air brake tubing assembly fittings shall be attached to the machine by suitable fixtures so that the tubing and fittings shall have a straight center line parallel to the direction of the machine pull.

- (A) Conduct the slow pull test by applying tension at a rate of 1" per minute. The assemblies shall withstand a minimum pull of 325 lbs.
- (B) Conduct the fast pull test by applying tension at a rate of 2" per minute. The assemblies shall withstand a minimum pull of 370 lbs.

Load vs. displacement will be permanently recorded.

### 12.D.19. – BOILING WATER CONDITIONING AND TENSILE STRENGTH TEST - (See Data Sheet P- 19)

- (A) Apparatus

Use a tension testing machine as specified in S8.9. The lower attachment point of the machine is equipped with a heated, open-top container that is water tight. The inside of the container (lower attachment point) and upper attachment point of the machine have provisions to quickly attach a brake hose assembly for tensile testing.

- (B) Preparation.

Prepare an air brake tubing assembly with a free length of 6 inches (six inches of exposed tubing between the end fittings), with the end fittings installed in accordance with the end fitting manufacturer's instructions. If necessary install adapters on the end fittings to permit quick attachment to the machine, to keep water from entering the tubing assembly, and to ensure that the tubing assembly is in a straight position when installed on the machine. Fill the container with distilled water such that the lower 4 inches of exposed tubing will be submerged when the brake tubing assembly is installed on the machine. Heat the water until it boils. Then quickly install the plastic air brake tubing assembly on the machine with the lower end of the tubing assembly in the boiling water. After the water has boiled continuously for 5 minutes, apply tension to the tubing assembly at a rate of 1 inch per minute travel of the moving head until either the conditioned tensile load in Table III for the size of tubing being tested is reached or the free length of the tubing assembly reaches 9 inches, whichever occurs first.

## **12. COMPLIANCE TEST EXECUTION....Continued**

### **12.D.20. – THERMAL CONDITIONING AND TENSILE STRENGTH TEST - (See Data Sheet P- 20)**

#### **(A) Apparatus**

Use a tension testing machine as specified in S8.9.

#### **(B) Preparation.**

Prepare an air brake tubing assembly with a free length of 6 inches (six inches of exposed tubing between the end fittings), with the end fittings installed in accordance with the end fitting manufacturer's instructions. If necessary install adapters on the end fittings to permit attachment to the machine, to keep water from entering the tubing assembly, and/or to ensure that the tubing assembly is in a straight position when installed on the machine. Subject the tubing assembly to four complete cycles of the following sequence:

- (i) Condition the tubing assembly in an environmental chamber at minus 40° F (-0° F, +2° F) for 30 minutes. Remove from the chamber and allow to warm at room temperature for 30 minutes.
- (ii) Condition the tubing assembly by submerging it in boiling water for 15 minutes. Remove and allow to cool at room temperature for 30 minutes.

Install the tubing assembly on the tension testing machine and apply tension to the tubing assembly at a rate of 1 inch per minute travel of the moving head until either the conditioned tensile load in Table III for the size of tubing being tested is reached or the free length of the tubing assembly reaches 9 inches, whichever occurs first.

### **12.D.21. – VIBRATION RESISTANCE TEST - (See Data Sheet P- 21)**

#### **(A) Apparatus**

A vibration testing machine that supports a brake tubing assembly by its end fittings in approximately a straight line and includes the following features:

- (i) One tubing assembly attachment point is fixed and the other moves in a plane perpendicular to a line projected between

## 12. COMPLIANCE TEST EXECUTION....Continued

the attachment points. The movable attachment point moves in a linear direction and travels 1/2 inch total and at its midpoint of travel falls on a line projected between the attachment points. The movable attachment point has a cycle rate of 600 cycles per minute.

- (ii) The distance between the attachment points is adjustable to compensate for varying lengths of brake tubing assemblies.
- (iii) The actuating mechanism for the movable attachment point is balanced to prevent introduction of machine vibration into the brake tubing assembly.
- (iv) The machine has a compressed air supply system that pressurizes the air brake tubing assembly through one fitting while the other fitting is plugged. The machine's compressed air supply system includes a pressure gauge or monitoring system and an air flow meter.
- (v) The machine is constructed so that an air brake tubing assembly mounted on it can be conditioned in an environmental test chamber.

### (B) Preparation

- (i) Prepare an air brake tubing assembly with a free length of 18 inches (18 inches of exposed tubing between the end fittings), with the end fittings installed in accordance with the end fitting manufacturer's instructions. Record the initial tightening torque for an end fitting that uses a threaded retaining nut.
- (ii) Install the air brake tubing assembly on the vibration testing machine and, with the movable attachment point at the midpoint of its travel, adjust the distance between the attachment points so that they are 1/2 inch closer together than the distance at which the tubing assembly is taut.
- (iii) With the tubing assembly inside the environmental chamber, apply compressed air to the tubing assembly at a regulated pressure of 120 psi and maintain the supply of air to the tubing assembly for the duration of the test. Set the temperature of the environmental chamber to 220° F (-2° F, +0° F) and initiate cycling of the movable attachment point. After 250,000 cycles, set the temperature of the environmental chamber to minus 40° F (-0° F, +2° F). After 500,000 cycles, set the temperature of the environmental

## 12. COMPLIANCE TEST EXECUTION....Continued

chamber to 220° F (-2° F, +0° F)). After 750,000 cycles, set the temperature of the environmental chamber to minus 40° F (-0° F, +2° F). Measure the air flow rate just prior to 1,000,000 cycles and if the compressed air flow rate supplied to the air brake tubing assembly exceeds 50 cm<sup>3</sup> per minute this constitutes failure of the test. Stop the cycling at 1,000,000 cycles and set the environmental chamber temperature to 75° F (-2° F, +0° F), while air pressure is still supplied to the air brake tubing assembly. After 1 hour, measure the compressed air flow rate supplied to the air brake tubing assembly and if the rate exceeds 25 cm<sup>3</sup> per minute this constitutes failure of the test.

- (iv) For end fittings that use a threaded retaining nut, apply 20 percent of the original tightening torque as recorded in S12.21(b)(i). If the retention nut visibly moves, this constitutes a failure of the test.

### 12.D.22. – END FITTING RETENTION TEST - (See Data Sheet P- 22)

- (A) Utilize an air brake tubing assembly or prepare a 12 inch length of tubing and install end fittings according to the end fitting manufacturer's instructions.
- (B) Plug one end of the assembly, fill it with water, and connect the other end to a source of water pressure. Bleed any air from the assembly and water pressure system.
- (C) Increase the pressure inside the tubing assembly at a rate of 3,000 psi per minute to 50 percent of the burst strength pressure for the size of tubing being tested as specified in Table III. Hold the pressure constant for 30 seconds.
- (D) Increase the pressure inside the tubing assembly at a rate of 3,000 psi per minute to the burst strength pressure for the size of tubing being tested as specified in Table III.

### 12.D.23. – THERMAL CONDITIONING AND END FITTING RETENTION TEST - (See Data Sheet P- 23)

- (A) Apparatus

A source of hydraulic pressure that includes a pressure gauge or monitoring system, uses ASTM IRM 903 oil, and is constructed so that an air brake tubing assembly mounted to it can be conditioned in an environmental test chamber.



## 12. COMPLIANCE TEST EXECUTION....Continued

### (B) Preparation

Utilize an air brake tubing assembly or prepare a 12 inch length of tubing and install end fittings according to the end fitting manufacturer's instructions. Attach one end of the assembly to the hydraulic pressure supply and plug the other end of the assembly, fill the assembly with ASTM IRM 903 oil and bleed any air from the assembly, and place the tubing assembly inside an environmental chamber. Conduct the following tests:

- (i) With atmospheric pressure applied to the oil inside the tubing assembly, set the environmental chamber temperature to 200° F (-2° F, +0° F) and condition the tubing assembly for 24 hours.
- (ii) With the temperature maintained at 200° F (-2° F, +0° F), increase the oil pressure inside the tubing assembly at a rate of 3,000 psi per minute to 450 psi, and hold this pressure for 5 minutes.
- (iii) Decrease the oil pressure inside the tubing assembly at a rate of 3,000 psi per minute to atmospheric pressure and set the temperature of the environmental chamber to 75° F (-2° F, +0° F). Condition the tubing assembly at this temperature for 1 hour.
- (iv) Set the temperature of the environmental chamber to minus 40° F (-0° F, +2° F) and condition the tubing assembly for 24 hours.
- (v) With the temperature maintained at minus 40° F (-0° F, +2° F), increase the hydraulic pressure inside the tubing assembly at a rate of 3,000 psi per minute to 450 psi, and hold this pressure for 5 minutes.

### 12.D.23. –END FITTING RETENTION SERVICEABILITY TEST - (See Data Sheet P-24 )

#### (A) Apparatus

A source of air pressure that includes a pressure gauge or monitoring system and is equipped with a mass air flow meter.

#### (B) Preparation.

## 12. COMPLIANCE TEST EXECUTION....Continued

Prepare a 12-inch length of tubing and plug one end. Assemble the end fitting with the threaded retention nut on the other end of the tubing according to the end fitting manufacturer's instructions, then disassemble the fitting. Repeat the assembly and disassembly sequence three more times, and then reassemble the end fitting (five total assembly steps).

- (C) Attach the end fitting with the threaded retention nut to the source of air pressure. Pressurize the tubing at a rate of 3,000 psi per minute to a pressure of 120 psi. If the end fitting leaks, measure and record the leakage rate using the mass air flow meter.

### 12.D.25. – END FITTING CORROSION TEST - (See Data Sheet P- 25)

Air brake tubing #14 shall be subjected to this test. Utilize the apparatus described in ASTM B117-03, "Standard Practice for Operating Salt Spray (Fog) Apparatus."

#### CONSTRUCTION -

Construct the salt spray chamber so that:

- (A) The construction material does not affect the corrosiveness of the fog.
- (B) The air brake tubing assembly is supported or suspended 30° from the vertical and parallel to the principal direction of the horizontal flow of fog through the chamber.
- (C) The air brake tubing assembly does not contact any metallic material or any material capable of acting as a wick.
- (D) Condensation which falls from the assembly does not return to the solution reservoir for respraying.
- (E) Condensation from any source does not fall on the brake tubing assemblies or the solution collectors.
- (F) Spray from the nozzles is NOT directed directly onto the tubing assembly.

#### PREPARATION -

- (A) Plug each end of the air brake tubing assembly.
- (B) Mix a salt solution five parts by weight of sodium chloride to 95 parts of distilled water, using sodium chloride substantially free of nickel and copper, and containing on a dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent total impurities.

## 12. COMPLIANCE TEST EXECUTION....Continued

Insure that the solution is free of suspended solids before the solution is atomized.

- (C) After atomization at 95° F (-2° F, +0° F) ensure that the collected solution is in the PH range of 6.5 to 7.2. Make the PH measurements at 77° F.
- (D) Maintain a compressed air supply to the nozzle or nozzles free of oil and dirt and between 10 and 25 psi.

### OPERATION –

Subject the brake tubing assembly to the salt spray continuously for 24 hours.

- (A) Regulate the mixture so that each collector will collect from 1 to 2 ml. of solution per hour for each 80 square centimeters of horizontal collecting area.
- (B) Maintain exposure zone temperature at 95° F (-2° F, +0° F).
- (C) Upon completion, remove the salt deposit from the surface of the air brake tubing by washing gently or dipping in clean running water not warmer than 100° F (-2° F, +0° F) and then drying immediately.
- (D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

### INSPECTION –

A brake tubing end fitting shall show no base metal corrosion on the end fitting surface except where crimping or the application of labeling information has caused displacement of the protective coating. Salt spray corrosion shall be noted as presence of red rust in the case of coated ferrous couplings or pitting in the case of brass couplings.

## 13. POST TEST REQUIREMENTS

The contractor shall re-verify all instrumentation and check data sheets and photographs. Make sure that data is recorded in all applicable data blocks on every Data Sheet.

## 14. REPORTS

### 14.1 MONTHLY STATUS REPORTS

The contractor shall submit a monthly Test Status Report and an Equipment Status Report to the COTR. The Equipment Status Report shall be submitted until all final

## 14. REPORTS....Continued

reports are accepted. Samples of the required Monthly Status Reports are contained in the report forms section.

### 14.2 APPARENT TEST FAILURE

Any indication of a test failure shall be communicated by telephone to the COTR within 1 working day with written notification mailed within 2 working days. A Notice of Test Failure (see report forms section) with a copy of the particular compliance test data sheet(s) shall be included.

In the event of a test failure, a post test calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COTR's discretion and shall be performed without additional costs to the OVSC.

### 14.3 FINAL TEST REPORTS

#### 14.3.1 COPIES

In the case of a test failure, **SEVEN** copies of the Final Test Report shall be submitted to the COTR for acceptance within three weeks of test completion. The Final Test Report format to be used by all contractors can be found in the attachment.

Where there has been no indication of a test failure, **FOUR** copies of each Final Test Report shall be submitted to the COTR within three weeks of test completion. Payment of contractor's invoices for completed compliance tests may be withheld until the Final Test Report is accepted by the COTR. Contractors are requested to NOT submit invoices before the COTR is provided copies of the Final Test Report.

Contractors are required to submit the first Final Test Report in typed draft form within two weeks after the compliance test is conducted. The contractor and the COTR will then be able to discuss the details of both test conduct and report content early in the compliance test program.

Contractors are required to PROOF READ all Final Test Reports before submittal to the COTR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

#### 14.3.2 REQUIREMENTS

The Final Test Report, associated documentation (including photographs) are relied upon as the chronicle of the compliance test. The Final Test Report will be released to the public domain after review and acceptance by the COTR. For these reasons, each final report must be a complete document capable of standing by itself.

## 14. REPORTS....Continued

The contractor should use **detailed** descriptions of all compliance test events. Any events that are not directly associated with the standard but are of technical interest should also be included. The contractor should include as much **detail** as possible in the report.

Instructions for the preparation of the first three pages of the final test report are provided below for the purpose of standardization.

### 14.3.3 FIRST THREE PAGES

#### A. FRONT COVER

A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

- (1) Final Report Number such as 106-ABC-XX-001

where —

106 is the FMVSS tested

ABC are the initials for the laboratory

XX is the Fiscal Year of the test program

001 is the Group Number (001 for the 1st brand,  
002 for the 2nd brand, etc.)

- (2) Final Report Title And Subtitle such as

SAFETY COMPLIANCE TESTING FOR FMVSS 106  
Brake Hoses

\*\*\*\*\*

ACE Manufacturing  
Sure-Safe Type 21 Air Brake Hose

- (3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.  
4335 West Dearborn Street  
Detroit, Michigan 48090-1234

**14. REPORTS....Continued**

**NOTE:** DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

- (4) Date of Final Report completion
- (5) The words "FINAL REPORT"
- (6) The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION  
National Highway Traffic Safety Administration  
Enforcement  
Office of Vehicle Safety Compliance  
Room 6111 (NVS-220)  
400 Seventh Street, SW  
Washington, DC 20590

**14. REPORTS....Continued**

**B. FIRST PAGE AFTER FRONT COVER**

A disclaimer statement and an acceptance signature block for the COTR shall be provided as follows

This publication is distributed by the U. S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared By: \_\_\_\_\_

Approved By: \_\_\_\_\_

Approval Date: \_\_\_\_\_

**FINAL REPORT ACCEPTANCE BY OVSC:**

Accepted By: \_\_\_\_\_

Acceptance Date: \_\_\_\_\_

## 14. REPORTS....Continued

### C. SECOND PAGE AFTER FRONT COVER

A completed Technical Report Documentation Page (Form DOT F1700.7) shall be completed for those items that are applicable with the other spaces left blank. Sample data for the applicable block numbers of the title page follows.

#### **Block 1 — REPORT NUMBER**

106-ABC-XX-001

#### **Block 2 — GOVERNMENT ACCESSION NUMBER**

Leave blank

#### **Block 3 — RECIPIENT'S CATALOG NUMBER**

Leave blank

#### **Block 4 — TITLE AND SUBTITLE**

Final Report of FMVSS 106 Compliance Testing of Sure-Safe Type 21 Air Brake Hose, Part No. 8456782

#### **Block 5 — REPORT DATE**

March 1, 20XX

#### **Block 6 — PERFORMING ORGANIZATION CODE**

ABC

#### **Block 7 — AUTHOR(S)**

John Smith, Project Manager  
Bill Doe, Project Engineer

#### **Block 8 — PERFORMING ORGANIZATION REPORT NUMBER**

ABC-DOT-XXX-001

#### **Block 9 — PERFORMING ORGANIZATION NAME AND ADDRESS**

ABC Laboratories  
405 Main Street  
Detroit, MI 48070-1234



**14. REPORTS....Continued****Block 10 — WORK UNIT NUMBER**

Leave blank

**Block 11 — CONTRACT OR GRANT NUMBER**

DTNH22-XX-D-12345

**Block 12 — SPONSORING AGENCY NAME AND ADDRESS**

US Department of Transportation  
National Highway Traffic Safety Administration  
Enforcement  
Office of Vehicle Safety Compliance (NVS-222)  
400 Seventh Street, SW, Room 6115  
Washington, DC 20590

**Block 13 — TYPE OF REPORT AND PERIOD COVERED**

Final Test Report  
Feb. 15 to Mar. 15, 20XX (Start Date to Completion Date)

**Block 14 — SPONSORING AGENCY CODE**

NVS-220

**Block 15 — SUPPLEMENTARY NOTES**

Leave blank

**Block 16 — ABSTRACT**

Compliance tests were conducted on Sure-Safe Type 21 Air Brake Hoses in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-106-XX. Test failures identified were as follows:

None

**NOTE:** Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COTR.

**14. REPORTS....Continued****Block 17 — KEY WORDS**

Compliance Testing  
Safety Engineering  
FMVSS 106

**Block 18 — DISTRIBUTION STATEMENT**

Copies of this report are available from--

National Highway Traffic Safety Administration  
Technical Information Services  
Room 2336 (NPO-405)  
400 Seventh Street, SW  
Washington, DC 20590  
Email: [tis@nhtsa.dot.gov](mailto:tis@nhtsa.dot.gov)  
Fax: 202-493-2833

**Block 19 — SECURITY CLASSIFICATION OF REPORT**

Unclassified

**Block 20 — SECURITY CLASSIFICATION OF PAGE**

Unclassified

**Block 21 — NUMBER OF PAGES**

Add appropriate number

**Block 22 — PRICE**

Leave blank

## **14. REPORTS....Continued**

### **14.3.4 TABLE OF CONTENTS**

Final test report Table of Contents shall include the following:

- |    |              |   |
|----|--------------|---|
| A. | Section 1 —  | Purpose of Compliance Test                      |
| B. | Section 2 —  | Compliance Test Data Summary                    |
| C. | Section 3 —  | Test Data                                       |
| D. | Section 4 —  | Test Failure Details (if applicable)            |
| E. | Appendix A — | Interpretations or Deviations From FMVSS 106    |
| F. | Appendix B — | Test Equipment List and Calibration Information |
| G. | Appendix C — | Photographs                                     |

## **APPENDIX A**

### **INTERPRETATIONS OR DEVIATIONS FROM FMVSS 106**

This Test Procedure (TP) is written in coordination with FMVSS 106 and is in no way intended to conflict with the requirements set forth in the standard and must be followed by the laboratory while conducting minimum performance compliance tests to FMVSS 106 for the Office of Vehicle Safety Compliance (OVSC), National Highway Traffic Safety Administration (NHTSA). If the testing laboratory interprets any part of this procedure to be in conflict with FMVSS 106, it will advise the Contracting Officer's Technical Representative (COTR) and resolve the discrepancy prior to testing to FMVSS 106.

Interpretations and/or deviations from this TP shall be shown in Appendix A of the Final Test Report.

**APPENDIX B****EQUIPMENT LIST AND CALIBRATION SCHEDULES**

TEST GROUP NO.: \_\_\_\_\_ ; INSP. DATE: \_\_\_\_\_

TESTING LABORATORY: \_\_\_\_\_

NOTE: Information to be included for each item of test instrumentation is as follows:

EQUIPMENT DESCRIPTION: \_\_\_\_\_

EQUIPMENT MANUFACTURER: \_\_\_\_\_

TYPE AND/OR MODEL: \_\_\_\_\_

SERIAL NUMBER: \_\_\_\_\_

LIMITS: \_\_\_\_\_

ACCURACY: \_\_\_\_\_

FREQUENCY OF CALIBRATION: \_\_\_\_\_

EXPIRATION OF CALIBRATION: \_\_\_\_\_

USED ON TEST NUMBER: \_\_\_\_\_

REMARKS:

RECORDED BY: \_\_\_\_\_ ; DATE: \_\_\_\_\_

APPROVED BY: \_\_\_\_\_

## **APPENDIX C**

### **PHOTOGRAPHS**

The test setup and equipment used therein are to be photographed for the record and the photographs inserted in this Appendices or a part of the Final Test Report. Normally one photograph of the test setup and equipment will suffice unless the setup is complicated and/or spread out thereby requiring two or more photographs. The equipment in the photos must agree with those items noted in Appendix B. Each photo must be accompanied by a suitable caption.